Geol survey

~~Gary D Baker~~ 3/3/94

GEOLOGIC EVALUATION OF THE PROPOSED NEW TOWN SITE

VALMEYER, ILLINOIS

Compiled by
Anne L. Erdmann and Robert A. Bauer

With contributions from:
Richard A. Cahill
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Illinois State Geological Survey
Open File Series 1993-12

Illinois State Geological Survey
615 E. Peabody Drive
Champaign, Illinois 61820

Morris W. Leighton, Chief

December 30, 1993

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EXECUTIVE SUMMARY

Following the devastation of the town of Valmeyer during the Mississippi River floods of 1993, the town voted to relocate to the uplands about two miles northeast of the former town site. A 550-acre site was selected for the new town, located in T2S, R11W, sections 35 and 36, and T3S, R11W, sections 1 and 2. At the request of Valmeyer town officials, on October 20, 1993, the Illinois State Geological Survey (ISGS) was asked to provide an evaluation of the geologic characteristics of the proposed town site and any potential geologic hazards that should be considered during the development of the site. This report is not an environmental site assessment and does not evaluate the potential presence of hazardous materials or other man-made hazards.

A draft version of this report was provided on November 6, 1993 to meet the November 8th deadline established by Valmeyer town officials. This report, dated December 30, 1993, incorporates revisions made during the ISGS open-file report review process.

The geologic setting of the new town site consists of limestone and shale bedrock, overlain by surficial deposits that are composed of about 40 feet of well-consolidated clayey soil materials, blanketed by about 30 feet of silt. Geology was verified by drilling boreholes at the site, geophysical soundings, site walkovers, and reference to previous field studies in the area.

The very gently-sloping upland areas of the site are generally considered suitable for construction. The ISGS did, however, identify five types of potential geologic hazards that should be considered during the development of the new town site. These hazards, from most to least potentially serious as evaluated for the new site, are those associated with the following:

- Presence of the windblown silt deposits (loess) that form the uppermost surficial unit over most of the site: erodibility, slope stability, and construction limitations.

- Features such as sinkholes that have resulted from soil piping or collapsing into crevices and caves in limestone bedrock as a result of water movement through the uppermost unit of the limestone bedrock (karst features).

- Potential occurrence of radon inside buildings to be constructed.

- Presence of limestone mines adjacent to the proposed site.

- Potential seismic hazard for the proposed site.

Many of these potential hazards can be mitigated or otherwise avoided through construction practices during development of the town site, and recommendations for mitigation or avoidance are presented in this report. The appendices contain logs of boreholes, detailed descriptions of geologic units, and the earth resistivity data collected at the site.

INTRODUCTION

On August 1 and 2, 1993, the town of Valmeyer was severely damaged by floodwaters from the Mississippi River when upstream levees protecting the town were overtopped and failed. Most of the town was inundated, in places to depths of 15 feet or more. The damage at Valmeyer was particularly severe. Floodwaters were channeled by an ancient river valley south from the levee break directly toward the town, resulting in erosion, scour, and large amounts of deposited sediment throughout much of Valmeyer. September rains caused another rise in floodwaters, inundating the town again and causing further damage.

Rather than rebuilding on the floodplain, in September 1993 the residents of Valmeyer voted to relocate the town to the uplands northeast of the former townsite. The 550-acre site selected for the new town is located in T2S, R11W, sections 35 and 36, and T3S, R11W, sections 1 and 2, approximately two miles northeast of the former town (Figure 1). This report provides a description of the geologic characteristics of the new site and a discussion of potential geologic hazards that should be considered during the development of the site. Additionally, recommendations for mitigation or avoidance of these potential hazards are presented. A map view of major site features is presented in Figure 2; the appendices contain detailed descriptions of geologic units, logs of boreholes, and the earth resistivity data collected at the site.

GEOLOGIC BACKGROUND

The proposed new location of Valmeyer is a bird-foot-shaped area of broad ridgetops, ravines, and depressions, located on the uplands bordering the Mississippi River floodplain. This section presents general background information on the geologic materials that define and control the landscape, including the soils, the surficial geology, and the bedrock geology.

Soils

Soil types in the project area all belong to the Alford series of soils, and are classified by the Soil Conservation Service (SCS) by whether or not they have developed on karst terrain (see section on karst features, page 8), and by the slope of the land surface on which they developed (Higgins, 1987). Characteristically, the Alford is a well-drained, moderately permeable silt loam, developed in loess (see section on surficial geology, below), with moderately low to low organic matter content. The SCS survey of Monroe County soils (Higgins, 1987) should be consulted for a detailed description of soil types at the proposed town site.

Surficial Geology

Composition of Surficial Deposits

The surficial deposits consist of about 20 to 40 feet of well-consolidated clayey soil materials, blanketed by about 30 feet of silt. This section discusses the composition of the deposits, which will be the primary foundation materials for all but the largest structures to be built on the site. A detailed description of the units and their history is given in Appendix 2. The units are presented here from top down (youngest to oldest), as they would be encountered in a typical excavation at the site.

The two main types of surficial deposits in the area consist of silt (loess) and heavy clayey soils (glacial deposits). Loess is a wind-deposited material composed mainly of silt that was eroded from the floodplain of the Mississippi River and transported eastward by wind. Glacial deposits consist of a mixture of clay, silt, sand, gravel, and boulders transported by glacial ice and deposited as the ice melted. They may contain sorted sand and gravel beds.

Peyton Formation The Peyton Formation consists mainly of reworked silt from loess, and is transported downward from surrounding slopes by slopewash, creep, and other erosion processes. At the project site, it is locally restricted to sinkholes and the lower parts of the bluff slopes. In these areas, these deposits may reach thicknesses of four feet or more.

Roxana and Peoria Silts In most parts of the new town site, the topmost surficial deposits are two loess units, the Roxana Silt and the overlying Peoria Silt. They are dominantly silt with some clay and trace amounts of sand, and have a combined thickness of about 30 feet. These loesses are relatively easily eroded, and are well exposed in numerous gullies along the large valleys on the site. They blanket the underlying Sangamon Geosol and become thinner near steep slopes and in sinkholes. The silts are known to be susceptible to moderate shrink-swell when subjected to wetting and drying.

Sangamon Geosol The Sangamon Geosol, a buried soil on an ancient landscape, occurs in the upper part of this sequence. Like the underlying weathered glacial deposits and residuum, it has a high clay content, which makes it much less permeable to water than the overlying loess deposits.

Older Glacial Till and Loess The Sangamon Geosol is underlain by deeply weathered loess and glacial till deposits of multiple older glacial episodes. The weathered till, loess, and underlying residuum deposits are over 30 feet thick in borehole IDOT-W. In other studies in the region, the clay fraction of these deposits has been shown to be high in expandable clay minerals that may be susceptible to shrink-swell when subjected to wetting and drying.

Residuum At the base of the surficial deposits is a sequence of clay-rich materials produced by the action of weathering on the bedrock. This residuum consists of insoluble constituents of the bedrock and other highly-weathered surficial materials. It is dominantly a reddish-brown silty clay that may contain chert fragments. It blankets the bedrock surface and may occur in crevices and fractures within the bedrock as observed in borehole IDOT-E.

Thickness of Surficial Deposits

The thickness of surficial deposits, where measured by boreholes and earth resistivity, is shown on Figure 3. Beneath the highest parts of the landscape on drainage divides, the surficial deposits are typically greater than 50 feet thick. A maximum thickness of 75 feet was measured on the site. The surficial deposits are thin on steep slopes, and near the base of slopes, the deposits consist of a thin mantle of silt and limestone cobbles. In many of the deep gullies bordering the town site, bedrock units are exposed and have no surficial deposit cover.

Bedrock Surface

The bedrock surface, as viewed in outcrops west of the site, has deep, solutionally-widened crevices and cavities, many of which are filled with soil. Deep erosional ravines that radiate from the central part of the site are cut deep into the bedrock, which is commonly exposed in stream bottoms and cut banks. The highest points on the bedrock surface have a regional dip to the northeast across the site, probably reflecting the regional dip of the underlying strata. Boreholes and earth resistivity soundings beneath the upland drainage divides in the area reveal that the regional dip of the bedrock surface is interrupted by irregularities. These are particularly evident in the northeastern part of the study area and are likely the result of weathering and dissolution of the carbonate bedrock. The major surface karst features mapped from aerial photography and surface expression (see section on karst, page 8) probably overlie lows in the bedrock surface. It is also possible that additional solution features may exist in the surface of the bedrock without expression at the ground surface.

Weathering of the bedrock surface, erosion to form the major gully features, and formation of karst features in the bedrock surface are likely the result of significant relief (adjacent to valleys), multiple episodes of bedrock exposure, and weathering during both recent times and repeated interglacial warm periods over hundreds of thousands of years.

Bedrock Geology

The bedrock supporting the prominent bluffs near Valmeyer is a sequence of layers of limestones up to 200 feet thick alternating with several shale units about 40 to 50 feet thick. In the vicinity of the new town site, these layers dip approximately 2° to the southeast. Field notes, drill hole descriptions, and publications of the ISGS from 1918 to today describe these bedrock materials; a detailed geologic description of the bedrock sequence is in Appendix 3. In general, the bedrock geology underlying the new town site can be simply described as follows (Figure 4). The topmost bedrock unit is typically a limestone (Salem Limestone), which may be up to 50 feet thick, or which may be absent. The next layer down is a shale (Warsaw Shale) that may be the topmost bedrock unit in places and can be up to 75 feet thick. This shale rests on a thick limestone succession or unit up to 200 feet thick (Keokuk, Burlington, and Fern Glen Formations) over a limestone-shale sequence 40 to 65 feet thick (Choteau Limestone, Hannibal Shale, and Scales Shale). The next layer down is the limestone layer, approximately 60 feet thick, in which the Columbia Quarry Company's mine has operated west of the proposed town site. This limestone is called the Kimmswick.

Structural features found in most bedrock are fractures or joints. Examination of the limestone layers in the area of the new town and in the mine showed the presence of some nearly vertical fractures. The most prevalent set of fractures is oriented nearly east-west (actual measurements are 70° east of north). These fractures are nearly vertical, dipping 5-10° from vertical. The average distance between these fractures may be about 50 feet, based on observations made in the pillars of the Columbia Quarry Company mine west of the proposed town site. Another set of fractures runs nearly north-south (actual measurements are 10-15° west of north). The average distance between these fractures is about 120 feet, as observed on a continuous quarry face.

POTENTIAL GEOLOGIC HAZARDS

First, it should be recognized that the very gently-sloping upland areas of the site are generally considered suitable for construction. The soils at the site are ideal for development in many respects. Developed on gentle upland slopes, these soils are uniform and can be easily excavated and graded. They are generally well-drained and free of rocks.

The ISGS did, however, identify five types of potential geologic hazards which should be considered during the development of the new town site. These hazards, from most to least potentially serious as evaluated for the new site, are those associated with:

- Presence of loess
- Karst features
- Radon occurrence
- Limestone mines
- Seismic events

In this section, each of these potential hazards will be addressed as follows. Background information on the hazard is presented, followed by specifics of the hazard as it relates to the proposed new town site. Finally, recommendations for mitigation or avoidance of the potential hazard are given.

Potential Hazards Associated with the Presence of Loess

Background

The soils in the area of the proposed new town are developed in thick loess, about 30 feet thick. As described earlier (page 4), loess is a deposit of fine-grained material that was transported and sorted by wind action. In many respects, these soils are ideal for construction. They are thick, uniform, and easy to excavate and grade. They are generally well drained and the upland slopes are gentle. However, loess is known to have some specific properties that may cause potential problems during construction. These properties make it very highly erodible, cause slope stability problems, and can result in several construction limitations because of its low strength when wet and its susceptibility to frost action. Consultation with city engineers familiar with construction in loess materials (Belleville and Collinsville), regional and county planning agency personnel (Soil Conservation Service, Southwestern Illinois Metropolitan and Regional Planning Commission), and local Department of Transportation personnel may be very beneficial in gathering first-hand experience in managing these potential problems.

Loess erodibility

Loess is very susceptible to being eroded. Very large gullies can develop in days or weeks if runoff is not controlled. Control of all waters from runoff, roofs, downspouts, sanitary, and paved areas is mandatory. Also, subsurface soil erosion (soil piping) can take place where water-carrying pipes and sewer lines have leaks. These processes cause a gradual settlement of the surface as loess is removed in the subsurface by moving water, resulting in possibly severe damage to surface structures.

Recommendations to mitigate loess erodibility include the following:

- Protect soil during construction to minimize loss and sedimentation downstream of the site.
- Construct a well-designed storm sewer system.
- Construct a sanitary sewer system - no septic fields.
- Connect all house gutters and downspouts to the storm sewer system.
- Line all catchment basins or ponds.
- During construction of any water-carrying system (sanitary and storm sewers and water lines), ensure that joints are tight and backfill is well-compacted, so that settlement will not create leaks at joints in the future.
- Seal all joints in any stormwater system components (such as in curbs or any concrete-lined waterways).

Many of these same recommendations should be followed to also control karst (sinkhole) development.

Slope stability

Loess and many other low-strength soil materials on steep slopes need special attention so that slope failure and damage to structures may be avoided. Recommendations to mitigate slope stability problems include the following:

- Avoid construction near steep slopes.
- Do not remove material from bases of slopes.
- Do not add weight to the top of the steep slopes by pushing soil material out over slopes to form more flat land to enlarge lot sizes.
- Do not construct septic fields.
- Do not allow excessive watering above or on steep slopes.
- Do not remove trees on steep slopes or near top of slopes.
- Create green belts along the tops of slopes so that an association or the town controls activities in these critical areas.

All of the practices for water control stated above in the section on loess erodibility also will enhance slope stability.

Construction limitations

Loess tends to lose its bearing strength when wet. When dry, loess may have bearing strengths 20 times higher than when it is wet. Bearing capacity measurements should investigate the degree of loss of strength so that designs of foundations are appropriate for this site. Also, control of water around buildings and other structures is imperative for their stability. Concentration of running water under concrete slabs and foundation footings will quickly undermine structures and cause loss of support.

According to the Soil Conservation Service (SCS), the soils in the area have a moderate shrink-swell limitation for dwellings and a severe limitation for local roads and streets because of the soils' low strength and susceptibility to frost action. The SCS recommends that foundations be reinforced and that foundation trenches be widened and backfilled with suitable coarse materials to help prevent structural damage from shrinking and swelling.

Loess in the area may be highly susceptible to frost heave. Slab-on-grade house and outbuilding construction, and local road construction, may have problems associated with frost heave. This potential problem should be investigated and proper construction techniques employed where necessary to minimize its impact.

Karst Features

Background

The infiltration of surface water into fractures in soluble carbonate rocks such as limestone is responsible for the development of karst terrain. The term "karst" is defined as terrain with distinctive landforms and hydrology that arise from two main factors: the ability of some carbonate rock to easily dissolve as a result of thousands of years of channeling storm runoff and snowmelt, and the presence of well-developed fracture systems. Features typical of karst terrain include closed depressions (sinkholes), caves, large springs, blind valleys, and swallow holes (White, 1988). The presence of fractures allows for the movement of large volumes of groundwater through the rock and the initiation of karst development. Karst features are common in Monroe and adjacent counties.

Dissolution of these rocks takes thousands of years and, in itself, is not a problem where the results are obvious. The problems arise when the dissolution feature is covered with tens of feet of loess or other material that bridge the enlarged feature. In these cases, the danger is hidden. Sinkholes form in loess in several ways. Collapse sinkholes are initiated as loess overlying a solution-widened bedrock fracture is washed downward into the fracture, forming a hollow soil dome above the fracture. Surface water draining into the soil along discrete pathways (soil piping) may remove small amounts of soil that make up the dome. Additional collapse may occur resulting in the enlargement of the soil dome (Figure 5). New sinkholes may have steep walls that extend from the surface to bedrock. At these thick loess sites, erosion of the steep walls of the hole occurs, rapidly forming a smoothed depression. Coalescing of two or more sinkholes will result in the formation of a compound sinkhole (Figure 6), such as the one seen in the northern arm of the site.

Subsidence sinkholes are formed as soil erodes into voids and other solution openings in the underlying bedrock. The surface sediments erode downward, grain by grain, as the underlying voids enlarge or as the sediment slowly moves into an existing network of cavities. This continuous, gradual subsurface erosion results in a slowly-developing subsidence sinkhole (Wilson and Beck, 1988).

Human activities can accelerate the sinkhole formation process by increasing and concentrating recharge of water to the loess and silt overlying karst bedrock. An increase in the movement of water through the soil can upset the delicate balance of soil materials overlying cavities and crevices. Roads, driveways, roofs, storm drains, retention ponds, and broken or leaking water or sewer pipes all can concentrate water runoff that can lead to the subsurface erosion of materials filling cavities in the limestones, subsurface piping, and cover collapse (Figure 7).

Interpretations for new town site

The soil at the proposed new town site is well-drained, and the water table is deeper than the soil-bedrock contact. A point that needs clarification here is that sinkholes filled with water do not always reflect the intersection of the water table by the sinkhole. The ponded sinkhole has trapped storm runoff that is slowly infiltrating into and through the sediments overlying bedrock.

Sinkholes, a diagnostic feature of karst areas, were mapped at the proposed town site from current and historical topographic maps, aerial photographs, and field observations. Stereo-pair sets of aerial photographs from 1950, 1962, 1968, and 1988 were used. The 1988 aerial photographs, however, have a very high contrast which resulted in poor resolution of sinkholes in some parts of the site. In addition, a single, enlarged, blue-line copy of an aerial photograph of the site taken in 1993 was used. Topographic maps used were from 1954, 1954 with 1968 photorevisions, 1954 with 1968 and 1974 photorevisions, and 1991.

The compiled results show that the proposed town site contains at least fourteen probable sinkholes (Figure 8), all of which are visible on the 1950 aerial photos. Most of the sinkholes (ten) are located on the northern arm of the site. Since 1950, the agricultural use of the land has tended to mask the presence of many of the sinkholes. In most cases, the land surface has been directly modified by the infilling of the sinkholes. In two cases, water is being drained from sinkholes by either a standing vertical tile pipe or by a horizontal run-off pipe. One of the ponded sinkholes contains a grate that drains overflow within the sink into one of the ravines. In some cases, the surface expression of the sinkhole has almost entirely disappeared through these practices.

The greater occurrence of sinkholes in the northern arm may be caused by thinner clayey glacial deposits overlying limestone bedrock; the western and southern part of the town site may have thin limestone over shale or only shale as the topmost bedrock unit (based on boreholes made at the site). Even though the loess is relatively thick in southwestern and southern Illinois, the occurrence of sinkholes generally appears to be related to the thickness of clayey till that lies on top of karst bedrock. This is probably caused by the ability of thick, cohesive clayey till to bridge cavities in the underlying limestone, whereas thin till tends to collapse into cavities, and with it the overlying loess.

Recommendations

Control of water in the area of the proposed town site is the most important factor in reducing the further development of karst features. Control of all waters from runoff, roofs, downspouts, sanitary and storm sewer systems, and paved areas is imperative. Leaks in any water or sewer conveyance system must be avoided. Most of the recommendations for erosion control in loess areas apply here as well. These include the following:

- Construct a well-designed storm sewer system.

- Construct a sanitary sewer system - no septic fields.

- Connect all house gutters and downspouts to the storm sewer system.

- Line all catchment basins or ponds.

- Eliminate areas that pond water on the surface.

- During construction of any water-carrying system (sanitary and storm sewers and water lines), ensure that joints are tight and backfill is well-compacted, so that settlement will not create leaks at joints in the future.

- Seal all joints in any stormwater system components (such as in curbs or any concrete-lined waterways).

Other concerns with karst in this area include the possibility of building structures over existing karst features that have been filled, and detection of karst features that have not yet reached the ground surface and collapsed. The locations of probable sinkholes, as shown on Figure 8, are presented for use in further investigating these sites to accurately determine what features are present and their precise locations.

Filling existing karst features and building over them without filling and sealing the subsurface cavity will only lead to continued downward movement of materials and lowering of the ground surface. Some of the practices that have been followed in building structures over known karst features include performing subsurface investigations through drilling, grouting the cavities closed, building deep foundations that extend into the bedrock, using dynamic compaction to collapse features, and building structures on grade beams across known features.

Many of these mitigation techniques can only be used properly if the locations of the karst features are known. Some may have only partially worked their way up to the ground surface. These may collapse during or after construction from vibrations or weight of equipment or the structures being built. Additional geophysical investigations using electrical resistivity or microgravity techniques may be used to find these features. Specific techniques that can be used in sinkhole delineation are described in "Evaluating sinkhole hazards in mantled karst terrane" (Wilson and Beck, 1988) and "Foundation design in karst terrain" (Destephen and Wargo, 1992).

Radon Occurrence

Background

Radon is a naturally-occurring radioactive gas that is present to some extent in all soils and rocks. It is colorless, odorless, tasteless, and chemically inert. As a result of public health studies indicating a correlation between exposure to radon and lung cancer, studies have been carried out in Illinois to assess the potential indoor levels of radon in houses throughout the state. To date, the Illinois Department of Nuclear Safety (IDNS) and the U.S. Environmental Protection Agency (USEPA) have reported results of indoor radon screening measurements in all 102 counties in Illinois.

Interpretations for new town site

The Illinois State Geological Survey has tabulated these measurements by zipcode regions, indicating areas in which the median levels exceed 4 picocuries per liter (pCi/L), the level at which USEPA recommends that action be taken to mitigate these levels. Results from IDNS indicate that about 31 percent of all indoor radon measurement in Illinois exceed the 4 pCi/L guideline, and about 1 percent have levels above 20 pCi/L, the level at which USEPA recommends that immediate action be taken to reduce levels.

For the zipcode including old Valmeyer and the new town site, six measurements were available. The median value was 4.5 pCi/L. The table below gives the values for all of Monroe County.

Indoor Radon Levels in Monroe County (IDNS 1992)					
	Number of measurements	Mean value (pCi/L)	Maximum value (pCi/L)	Number of measurements exceeding 4 pCi/L	Percent of measurement exceeding 4 pCi/L
Basement	24	5.7	15.4	12	50
First Floor	2	3.0	3.5	0	0
Total	26	5.5	15.4	12	46

Recommendations

The results for Monroe County and the area near Valmeyer illustrate the variable nature of indoor radon measurements, and the lack of information for many areas within Illinois, including the new Valmeyer town site. Any area in Illinois could have indoor radon screening measurements that exceed 4 pCi/L. The construction practices used to build a new town could easily incorporate methods that could reduce the risk of elevated indoor radon levels at a low cost. The town is encouraged to consult the Illinois Department of Nuclear Safety for specific building guidelines.

Limestone Mines

Background

Located to the west of the proposed new town site is an underground limestone mine (Figure 2) operated by the Columbia Quarry Company. The rock being mined is a high-purity, massive, coarse-grained unit that is part of the formation known as the Kimmswick Limestone (see Appendix 3). The Kimmswick was first quarried at this site in 1918, and underground mining began in about 1927. The mine operated until about August of 1992, utilizing the room-and-pillar method of mining.

Interpretations for new town site

The extent of mining of the Columbia Quarry mine as presented on a map supplied by the company is shown on Figure 2. The mine map and a visit to the easternmost part of the mine showed the pillars to be roughly 40 to 50 feet across and 50 to 60 feet apart, which represents an extraction ratio of about 75 percent. (The lower the extraction ratio, the more material that has been left in place to support the overlying ground.) In this part of the mine the opening was about 26 feet high. The pillars did not show signs of being overstressed; the sides of the pillars were vertical and the corners were roughly square. The roof of the mine was stable with no roof falls noted except near the entrance of the mine on its west side, where the limestone roof is a few feet thick and at the ground surface.

No water was observed to be entering the mine. The mine stopped pumping out water when it was idled about 1.5 years ago, and since then little water has collected in the mine, indicating that very little infiltration is occurring. The overlying shale layer(s) appear to hinder downward movement of water. Also no dissolution features, excessive widening of joints, or formation of voids in the limestone were noted in the mine. (See section on bedrock geology, page 5, for a discussion of the joints observed in and around the mine.)

As shown on Figure 2, a small part of the easternmost limit of the mine is at present located about 300-400 feet west of the proposed southwesternmost corner of the proposed boundary of the new town site, based on a mine map supplied by the company. The limestone layer in which the mine operated is about 400 feet below the site.

Underground limestone mines near major metropolitan areas produce two valuable commodities: limestone and space. The Columbia mine's extraction ratio of 75 percent is less than the typical extraction ratio of 85 percent performed in limestone mines in the Kansas City area, where the mined-out areas have been converted into office, warehouse, and industrial space occupied by thousands of office workers daily.

Recommendations

Purchase of the mineral rights below the proposed new town site would give residents peace of mind concerning undermining, even though a site-specific analysis would probably show the mine pillars (using current mine design) to be much larger than required to support the ground surface. If mineral rights to the property cannot be acquired, then mining may continue eastward underneath the town site, resulting in annoyance from blasting and possible triggering of the collapse of karst features that have not yet reached the ground surface.

Potential Seismic Hazard

Background

Monroe County is within the area influenced by seismic activity along the New Madrid fault system. This fault system extends from Marked Tree, Arkansas into Alexander County in southern Illinois.

Interpretations for new town site

Federal Executive Order 12699, "Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction" may apply to the new construction at Valmeyer. The Executive Order applies to new construction of all buildings owned, leased, constructed, assisted (through such methods as loans, grants, or guarantees of loans), or regulated by the Federal government. It requires that appropriate seismic design and construction standards are applied to new construction under each agency's purview.

The Executive Order requires that nationally recognized private sector standards and practices be used if possible. The Order recommends the use of codes, regulations and procedures which are substantially equivalent to the most recent or the immediately preceding edition of The National Earthquake Hazard Reduction Program's "Recommended Provisions for the Development of Seismic Regulations for New Buildings".

Recommendations

Under this Order the "agency" applicable to this situation is FEMA, which will have to be contacted to determine its provisions for following this Order.

ACKNOWLEDGEMENTS

We wish to thank the following for their assistance. George Andres of the Southwestern Illinois Metropolitan and Regional Planning Commission provided maps and copies of previous ISGS reports. Allen Guttman, Materials Section, arranged for District 8 of the Illinois Department of Transportation to conduct two test boreholes at the site. Paul Kremmel of the Monroe County Soil and Water Conservation District and Sam Indorante and Randy Leeper of the Soil Conservation Service provided assistance in reviewing soil boreholes. Sid Trexler, owner of the Columbia Quarry Company, provided maps and access to the company's mine west of the proposed site. Walter Stemler and his brother Phillip, land owners and residents, were gracious hosts. Valmeyer Mayor Dennis Knobloch and his staff have been most cooperative in supplying us with materials to conduct our investigation. Several additional staff of the ISGS provided invaluable information, comments, and advice to make this report possible.

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APPENDIX 1: Borehole logs

Appendix 1 contains logs of the materials encountered during drilling of the four boreholes at the proposed town site. Pages 17 through 20 contain field descriptions of the surficial materials encountered in the four boreholes drilled by ISGS. Pages 21 through 22 contain a description of the surficial materials encountered near the site of ISGS borehole 1 in borehole IDOT-2 (West Site), beginning at a depth of 29.5 feet and continuing to bedrock. Pages 23 through 25 contain descriptions of the bedrock units encountered in boreholes IDOT-1 and IDOT-2.

ISGS	**LOG OF TEST BORING**	**BORING NO.:** ISGS-1
PROJECT: Valmeyer Relocation		**SHEET** 1 **of** 1
LOCATION: (see figure 8)		**BY:** McKay **DATE:** 10/26/93
COUNTY: Monroe	**QUAD:** Valmeyer, IL-MO	**ELEV:** 767 TM

SAMPLE NO.	SAMPLE TYPE
1	0 - 3.5' Soiltube
2	3.5-7.5'
3	7.5-11.0'
4	11.0-15.0'
5	15.0-19.0'
6	19.0-22.5'
7	22.5-26.0'
8	26.0-29.0'
9	29.0-32.5'
10	32.5-33.5'

GRAPHIC LOG: BW, Bt

DEPTH (FT.): 5, 10, 15, 20, 25, 30

DESCRIPTION

Peoria Silt-leached light yellowish brown silt loam below modern solum, common pores. Tan to light gray mottles (loess). Surface horizon appears to be truncated, entire thickness of Peoria is noncalcareous and moist but not saturated.

Fracture prominent in Peoria coated with light gray silans.

Lower contact very gradual.

Roxana Silt - silt loam, brown. Common pores. No apparent r-4. All of Roxana is noncalcareous and has weak soil structure.
Color zone r-3 (loess).

Roxana Silt-reddish brown silt loam zone r-2 (loess).

Zone r-1/2 Transition between reddish brown above and grayish brown below.

Zone r-1 (loess)

A/C Weak granular light grayish brown.

BW Yellowish brown silt loam with many FF/MM. Concretions, fine blocky structure, no sand (loess).

--

Bt Yellowish brown clay loam grading downward to pebbly clay loam, coarse blocky structure, with bright orange mottles and dark gray argillans (diamicton) chert and quart granules common.

T.D. 33.5'

No free water encountered. Hole dry after 24 hours.

ISGS	LOG OF TEST BORING	BORING NO.: ISGS-2	
PROJECT: Valmeyer Relocation		SHEET 1 of 1	
LOCATION: Sink southwest of hole #1 (see figure 8)		BY: McKay	DATE: 10/26/93
COUNTY: Monroe	QUAD: Valmeyer, IL-MO	ELEV: 758 TM	

SAMPLE NO.	SAMPLE TYPE	GRAPHIC LOG	DEPTH (FT.)	DESCRIPTION
Continuous soil tube samples			0–5	Peyton Colluvium Cumulic surface soil. Somewhat poorly drained. Overthickened surface horizon, slope-wash.
			5–10	Peoria Silt-light grayish brown silt loam A' to silty clay loam B2; silt loam C (loess)
			10–17	Roxana Silt--silt loam, noncalcareous brown (loess)
			17–22	Reddish brown silt loam (loess) r-2
			22–27	lighter grayish brown silt loam (loess) r-1
			27–	N/E ~~B2 in loamy~~ sediment; pebbly clay loam with few subangular chert granules, manganese and iron stains strong brown with orange-brown mottles. Coarse blocky structure stone (granule) concentration at top. (Diamicton) T.D. 28.5

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

ISGS	LOG OF TEST BORING	BORING NO.: ISGS-3
PROJECT: Valmeyer Relocation		SHEET 1 of 1
LOCATION: 38° 18.37N 90° 17.07W (see figure 8)		BY: McKay — DATE: 10/27/93
COUNTY: Monroe	QUAD: Valmeyer, IL-MO	ELEV: 772 TM

SAMPLE NO.	SAMPLE TYPE	GRAPHIC LOG	DEPTH (FT.)	DESCRIPTION
Continuous soil tube samples				Peoria Silt
			5	
				Units appear much as they did in ISGS-1
			10	
			15	r-3 Roxana Silt - brown silt loam (loess)
			20	r-2 Reddish brown silt loam (loess)
			25	r-1 Grayish brown silt loam (loess)
				B-1 Silty clay loam
				B-2 Sility clay loam with few granules and coarse sand grains, yellowish brown with manganese and iron stains.
			30	T.D. 30' blocky.

ISGS LOG OF TEST BORING	BORING NO.: ISGS-4	
PROJECT: Valmeyer Relocation	SHEET 1 of 1	
LOCATION: (see figure 8)	BY: McKay	DATE: 10/27/93
COUNTY: Monroe QUAD: Valmeyer, IL-MO	ELEV: 742 TM	

SAMPLE NO.	SAMPLE TYPE	GRAPHIC LOG	DEPTH (FT.)	DESCRIPTION
Continuous soil tube samples			5	Peoria Silt- silt loam (loess) yellowish brown to grayish brown noncalcareous
			10	
				Roxana Silt-silt loam (loess) brown, noncalcareous
			15	r-3
			20	r-2 Reddish brown silt loam (loess)
			25	r-1 Grayish brown silt loam (loess)
				A
			30	B2 Sangamon Geosol-silty clay loam rare sand grains; mottled yellowish brown with iron stains, few manganese concretions
				T.D. 31.0'
			35	

New Valmeyer Core Description—IDOT-2 (West Site)
NE Section 2, T2S-R11W, Monroe County
Study by Leon Follmer
November 1993

NOTE: Corebox contained unwrapped split-spoon core segments and bagged segments from unconfined compressive test. Bagged samples are assumed to mark top of interval sampled. The following is a generalized description with comments on notable features.

Sample	Depth in feet Top	Bottom	Description Soil horizon, color, soil texture, comments
1a	29.5	30.5	CA, brown silt loam, few pedogenic features noncalcareous, base of Roxana Silt (?).
1b	30.5	31.0	E-BE, brown and gray silt loam, many pedo features but disturbed and compacted, top of 3rd loess, (Sangamon Geosol).
2	32.0	33.0	BE-Bt, brown and gray mottled silty clay loam and silty clay, strong argillic horizon expression, may be loess.
3	33.0	33.5	Bt, yellowish brown silty clay, yellowish color suggests it may be loess.
4	34.5	36.0	Bt, lower similar to above.
5a	37.0	38.0	Bt, similar to above.
5b	38.0	38.5	ABg (?), gray clay with masses of laminated silt, probably an accretion gley in a basin and derived from residuum (Geosol 2).
6	39.5	41.0	Bg, olive gray clay, low sand, weak pedo features.
7	42.0	43.5	Btt, brown clay, strong development of subspherical millimeter-scale forms (klumpen) and laminated clay-skins (argillans), compressed, short range slickensides. B horizon of an in situ mature soil of a temperate climate; top may have been truncated, Bg above is an unconformable relationship.
8	44.5	46.0	Btt, brown clay, secondary porous silica in joint, one siliceous pebble with bryozoan fossils, excessive pedogenic clay accumulation in residual soil.
9a	47.0	48.0	Btt, brown clay similar to above.
9b	48.0	48.5	AE, brown clay with more sand, many rounded pedo forms with thick reddish argillans, compressed, probably colluvial surficial (aggregated) sediments from residuum (Geosol 3).
10	4.95	51.0	Btt, brown clay, low sand.

11a	52.0	53.0	Btt, brown clay.
11b	53.0	53.5	A, reddish brown clay with strong expression of compressed rounded aggregates (Geosol 4).
12a	54.5	56.0	Btt, brown clay.
12b	56±		C, brown, single grain limestone.
13	57.0	58.5	C, brown, single grained limestone.
14	60±		Bgtt, light olive gray clay, mottled, resembles a mature soil in shale (tongue of Geosol 4?).
15	60±		Bt, olive brown mottled clay, soft deformed (likely out-of-place).

COMPANY:	IDOT
FARM:	Boring #1, East Site
DATE DRILLED:	October 27-28, 1993
ELEVATION:	740 feet (est.)
LOCATION:	Sec. 35, T2S-R11W, SE SE SE
COUNTY:	Monroe County (Valmeyer, IL)

Core study by Zakaria Lasemi
November 3, 1993

	Top	Bottom
	In Feet	
Limestone, very light gray to very light yellow gray, fine-grained, well sorted and rounded, mostly bryozoan grainstone, mostly coated (pseudo-oolitic, some oolitic), calcite-cemented; few faint stylolitic partings in lower 6 inches.	44.00	46.25
Clay Loam, brown	46.27	47.00
Limestone, very light gray, crinoid-bryozoan grainstone, medium-grained, dense, moderately sorted and rounded, some grains slightly coated (pseudo-oolitic), weathered zone at top with a syringopora coral.	47.00	48.00
Limestone, light gray to very light brownish gray, medium- to coarse-grained, mainly crinoidal-bryozoan grainstone, rare brachiopods and forams (endothyrids), in part slightly pseudo-oolitic, moderate rounding, faintly laminated to cross-laminated.	48.00	49.60
Lime mudstone, light brownish gray, dense.	49.60	50.10
Clay Loam.	50.10	50.60
Lime mudstone, as above, stylolitic near top.	50.60	50.90
Clay Loam with a few chert fragments.	50.90	51.10
Chert, light gray to light olive gray, slightly calcareous, ghosts of original cross-lamination; vertical fracture along joint.	51.10	51.60
Clay Loam with broken pieces of light gray chert.	51.60	52.00

IDOT
MONROE COUNTY
COMPANY:IDOT

Boring #2
2-2S-11W

FARM:	West Site, Boring #2
DATE DRILLED:	October 27-28, 1993
ELEVATION:	770 feet (est.)
LOCATION:	Sec. 2, T3S-R11W, NE NW NE
COUNTY:	Monroe County (Valmeyer, IL)

Core studied by Zakaria Lasemi, November 3, 1993.

Description	Top (In Feet)	Bottom (In Feet)
Limestone, light olive gray skeletal wackestone to packstone with abundant crinoids and bryozoans, rare brachiopods, gastropods and solitary corals, dense, partly weathered.	63.50	64.10
Shale, greenish gray, fossiliferous with crinoidal wackestone to packstone nodules.	64.10	64.20
Limestone, light brownish gray to light gray, fine-coarse skeletal grainstone with abundant crinoids and some bryozoans, other fossils include rare gastropods, and brachiopods, some grains are coated (pseudo-oolitic), rare oolites; upper 3 inches is stylolitic.	64.20	64.90
Limestone, light gray, mostly fine-medium skeletal grainstone, abundant crinoids and bryozoans, some brachiopods, rare gastropods and endothyrid forams, common coated grains (pseudo-oolitic), become argillaceous at base, stylolites at top and at 2.5 inches below the top, numerous stylolitic partings in lower 1.5 feet, becomes more stylolitic at base.	64.90	67.30

	Top	Bottom
	In Feet	
Limestone, medium gray to medium dark gray, very fine-coarse, bryozoan wackestone to packstone, some crinoids, argillaceous, slightly siliceous.	67.30	67.65
Shale, dark gray to dark brownish gray, fossiliferous, numerous medium gray crinoidal packstone/wackestone nodules.	67.65	68.10
Limestone, medium dark gray, speckled very light gray, mainly a fine to coarse packstone/grainstone, abundant crinoids and bryozoans, some brachiopods and endothyrids forams, rare gastropods and peleypods, slightly argillaceous, some pseudo-oolitic grains; basal 1.5 feet very shaly.	68.10	68.80
Limestone, medium dark gray to light gray, speckled very light gray and dark gray, fine-coarse grainstone, many coated grains, some oolitic, abundant crinoid and bryozoans, common endothyrid forams, some brachiopods.	68.80	69.60

-0.9 feet core loss, mainly at base.

APPENDIX 2: Detailed description of surficial units

The Paleozoic limestone and shale terrain of the area is overlain by up to 75 feet of loosely consolidated soil materials, referred to here as surficial deposits. This section discusses the composition and age of the deposits, which will be the primary foundation materials for all but the largest structures to be built on the site.

Surficial deposits on the site were deposited during a part of earth history referred to as the Quaternary (commonly referred to as the Ice Age), which spans the past two million years or so. Although their exact age has not been determined, most of the deposits on the site originated during the latter part of the Quaternary, probably during the past several hundred thousand years. The following discussion begins with the oldest and lowermost units and ends with the youngest and uppermost deposits on the site, as is standard geologic convention. Note that in the text, the materials are presented from top down, in the order that they would be encountered during drilling or excavation in the area.

<u>Residuum</u> At the base of the surficial deposits is a sequence of clay-rich materials produced by the action of weathering on the bedrock. It consists of insoluble constituents of the bedrock and other highly weathered surficial materials. The residuum is observed primarily in bore-hole samples and scattered stream exposures. It is dominantly a reddish brown silty clay that may contain chert clasts. It blankets the bedrock surface and may occur in crevices and fractures within the bedrock as observed in borehole IDOT-E.

<u>Pre-Illinoian Glacial Till and Loess</u> The residuum is overlain by deposits of two types, loess and glacial till. Loess is a wind deposited material composed mainly of silt that was eroded from the floodplain of the Mississippi River at times of glaciation to the north. During these times, flooding in the valley left silt exposed to winds when flood waters receded. The silt eroded by wind was transported in dust storms and deposited in the uplands downwind of the valley. These deposits are thickest near the valley and become thinner with increasing distance away from it. Loess deposits tend to blanket the surface on which they were deposited.

Glacial till overlying the residuum was deposited several hundred thousand years ago during a glacial period when glaciers flowing through the Lake Michigan Basin from Canada spread southward across Illinois reaching as far south as Jackson County. These deposits consist of a mixture of clay, silt, sand, gravel and boulders transported by glacial ice and deposited as the ice melted. They may contain sorted sand and gravel beds.

In the study area the residuum is overlain by deeply weathered loess and glacial till deposits of multiple glacial episodes collectively referred to as Pre-Illinoian. Weathering of the deposits proceeded rapidly during warm interglacial episodes when the climate was similar to today's. Weathering created thick clay-rich soil profiles referred to as paleosols. In boreholes on the site, the weathered Pre-Illinoian till, loess, and residuum deposits are over 30 feet thick in borehole IDOT-W. Where sampled, the firm clay-rich deposits are reddish-brown to brown and have strongly-expressed soil structure. In other studies in the region, the clay fraction of these deposits has been shown to be high in expandable clay minerals that may be susceptible to shrink-swell when subjected to wetting and drying.

<u>Sangamon Geosol</u> The Sangamon Geosol, a buried weathering profile (or paleosol) on an ancient landscape, developed during the last interglacial (warm) period 110,000 to 70,000 years ago and occurs in the upper part of this sequence. Limited exposures of the Sangamon Geosol and the upper part of the

Pre-Illinoian deposits occur in gullies on the site. The paleosol has a reddish brown silty clay loam to silty clay B-horizon that is 2 to 3 feet thick. Like the underlying weathered Pre-Illinoian deposits and residuum, it has a high clay content, which makes it much less permeable to water than the overlying loess deposits.

Roxana and Peoria Silts The Sangamon Geosol is overlain by two loess units deposited during the last glacial period between about 50,000 and about 12,500 years ago. These units, the Roxana Silt and the overlying Peoria Silt, are dominantly silt with some clay and trace amounts of sand. They are non-calcareous, brown to reddish brown, and relatively less weathered and less cohesive than underlying units. The combined thickness of the Peoria and Roxana is 27, 28.5 and 30 feet in three ISGS boreholes drilled on upland drainage divides at the site. At borehole ISGS-2, which was drilled in a sinkhole, the combined Peoria and Roxana are 22.5 feet thick. These loesses are relatively easily eroded and well exposed in numerous gullies on the site. The Roxana is divisible into easily recognized color zones that can be traced from gully exposures into the subsurface and between boreholes. The most distinctive is a reddish brown zone in the lower half of the deposit called zone "r-2" in the cross section (Figure 3). It is distinguished from overlying and underlying color zones, which are brown but lack the distinctive reddish cast. Physical tracing of the loess units and Roxana color zones shows that the Peoria and Roxana blanket the underlying Sangamon Geosol and become thinner near steep slopes and in sinkholes.

Peyton Formation Slopewash and colluvial processes have deposited the Peyton Formation in sinkholes and on slopes. Where encountered in a sinkhole in borehole ISGS-2, the Peyton is 4.5 feet thick and is composed of grayish brown silt loam. The deposit is interpreted as the accumulation of sediment washed from surrounding cultivated slopes. At ISGS-2, the Peyton overlies a complete profile of the modern soil. Thus, it probably records erosion of surface soil from adjacent slopes accelerated by clearing and cultivation. Elsewhere, the Peyton occurs on steep slopes and is characterized by silty slopewash, derived from upslope loess. Below the elevation of limestone outcrops, the silty matrix is mixed with limestone cobbles.

APPENDIX 3: Detailed description of bedrock units

The sequence of bedrock units from the base of the Quaternary deposits down through the next major unit below the Kimmswick limestone is interpreted as follows:

Mississippian System

Valmeyeran Series

Salem Limestone. Up to about 90 feet of biocalcarenite consisting of angular to rounded fossil fragments and some whole small fossils, commonly coated with concentric oolite-like bands of calcite. Endothyrid foraminifers are present. The matrix is filled with micritic to sparry calcite. It develops solution features when exposed to weathering. Some Ullin Limestone may occur between the Salem and the Warsaw, but at this time it has not been identified.

Warsaw Shale. About 60 feet of calcareous, gray shale with beds of fossiliferous, argillaceous limestone.

Burlington, Keokuk (and Fern Glen at the base) Formations. About 200 feet of interbedded limestone and chert with abundant shale near the top and bottom of the interval. The limestone is usually light gray, crinoidal and coarsely crystalline, with beds and nodules of very light gray to off-white chert, and gray shale beds that become more abundant and thicker near the top. The lower 30 feet or so of the limestone is interbedded with shale and is greenish to reddish-gray.

Kinderhookian Series

Hannibal Shale and Chouteau Limestone. The Chouteau consists of about 2 feet of light gray, fine grained limestone with thin shale beds. It overlies at least 10 feet of Hannibal Shale. The Hannibal is so similar to the underlying Scales Shale that the position of the unconformity has not been confirmed. The Scales, Hannibal, and Chouteau are combined on cross-section B-B'.

Major erosional unconformity

Ordovician System

Maquoketa Group

Scales Shale. Up to 25 feet of mainly olive-green to gray shale that tends to become dolomitic toward the base, where diminutive fossils and phosphate nodules are often present.

Galena Group

Kimmswick Subgroup

Dunleith Formation, Moredock Member. This unit is commonly known as the "Kimmswick limestone" in the Valmeyer area, and that name is used throughout this report. It is about 90 feet thick and consists of massive, coarse-grained calcarenite, often very light gray with abundant slightly darker pinkish, brownish and grayish color bands. The upper 60 feet or so is the high-calcium limestone interval mined by Columbia Quarry company. The lower part of the unit contains cherty bands.

Decorah Subgroup. About 30 feet of thin-bedded, tan, very fine-grained limestone interbedded with brown-red shale, overlying interbedded greenish shale and thin, dense, fine-grained limestone.

Platteville Group. At least 300 feet of undivided dominantly fine-grained and lithographic limestone.

APPENDIX 4: Resistivity data

A reconnaissance resistivity survey consisting of 11 Vertical Electrical Soundings (VES) was conducted October 27-28, 1993 at the proposed new town site for Valmeyer, Illinois (Section 35, T2S R11W, and Section 2, T3S R11W, Monroe County). Wenner electrode arrays were used with a-spacings ranging from 5 to 160 feet. Data were processed using Zohdy's automatic inversion method.

Similar patterns of resistivity layering parameters were observed at each station. Disregarding thin surface layers, typical resistivity layering parameters included a shallow, moderately low resistivity layer, above a transitional layer having moderately high resistivity, above a very high resistivity bedrock.

GENERALIZED RESISTIVITY LAYERING PARAMETERS

Layer	Resistivity (ohm-ft)	Thickness (ft)	Interpretation
1	57-160	48-75	Drift and regolith
2	225-1236	20-65	Limestone, fractured
3	505-8300	-	Limestone, solid

Layer 1 is a shallow, low resistivity layer interpreted to be Quaternary drift and regolith. Some resistivity stations detected layers within the drift, but no intra-drift layers were consistently detected at all stations. One very low value (VES station 11) may represent till. The moderate resistivity layer beneath the drift (layer 2) is interpreted to be fractured limestone. Layer 3, a deeper, very high resistivity layer, is within the bedrock and probably represents a change to unfractured limestone bedrock.

In general, resistivity values increase from south to north, for each of the three layers. This probably is a result of increased weathering in the narrow fingers of flat land which extend into the northern parts of the study area. Except near the ravine on the eastern border of the area (VES station ER-10), all resistivity values south of the Section 35/2 boundary line are relatively low for each layer. This probably indicates that this southern part of the area is underlain by less weathered material. It is also possible that regional structural dip, which is about 4° NE, could influence the northerly increase in resistivity values in Layers 2 and 3 by causing limestone thickness to increase from south to north.

Land surface elevations were estimated from 7.5-minute topographic maps and are accurate to approximately ± 5 feet. Despite this coarse vertical control, a clear east-west trend is apparent in the elevation of the surface at the base of layer 1. In the western part of the study area (VES stations ER-1, ER-2, and ER-11) this surface, interpreted to be the top of bedrock, has an elevation of about 700 feet. The elevation of the top of bedrock generally drops eastward to less than 680 feet at stations ER-6, ER-8, ER-9, and ER-10.

RESISTIVITY DATA

DATA COLLECTED OCTOBER 27-28, 1993

WENNER ARRAY
ABEM TERRAMETER 300B

STATIONS 1 THROUGH 11

UNITS:

AB/2	FT
OBS	OHM-FT
REDUCED THICKNESS	FT
REDUCED DEPTH	FT
REDUCED RESISTIVITY	OHM-FT

REDUCED RESISTIVITY CALCULATED USING ZOHDY'S AUTOMATIC ITERATION METHOD

STA ER-1 APPROXIMATE ELEVATION 765 FT

AB/2	OBS
5.000	84.190
10.000	88.470
15.000	92.460
20.000	99.530
30.000	102.900
40.000	100.700
50.000	107.100
60.000	107.000
70.000	114.700
80.000	123.600
90.000	135.700
100.000	152.000
120.000	171.900
140.000	204.000
160.000	221.100

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
6.75903	6.75903	82.92364
9.12044	15.87947	105.42780
45.06194	60.94141	88.69743
35.27630	96.21771	329.56200
99999780.00000	99999880.00000	514.41760

STA ER-2 APPROXIMATE ELEVATION 755 FT

AB/2	OBS
5.000	165.200
10.000	141.300
15.000	118.800
20.000	107.800
30.000	102.500
40.000	105.300
50.000	111.800
60.000	121.000
70.000	133.200
80.000	141.700
90.000	156.600
100.000	167.100
120.000	201.300
140.000	225.100
160.000	257.300

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
6.42872	6.42872	175.75990
47.95426	54.38298	91.12684
51.78022	106.16320	237.35540
99999060.00000	99999160.00000	2413.28700

STA ER-3 WITHOUT A=5   APPROXIMATE ELEVATION 760 FT

AB/2	OBS
10.000	95.750
15.000	101.000
20.000	103.900
30.000	106.800
40.000	111.500
50.000	109.900
60.000	114.600
70.000	113.900
80.000	123.100
90.000	127.800
100.000	142.000
120.000	153.000
140.000	187.300
160.000	204.000

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
66.54259	66.54259	95.56460
46.39721	112.93980	257.84090
99999760.00000	99999870.00000	504.56770

STA ER-4 APPROXIMATE ELEVATION 735 FT

AB/2	OBS
5.000	82.000
10.000	88.000
15.000	94.340
20.000	97.640
30.000	108.200
40.000	122.100
50.000	143.500
60.000	156.800
70.000	175.400
80.000	193.000
90.000	214.300
100.000	234.300
120.000	273.700
140.000	320.100
160.000	365.900

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
9.46326	9.46326	78.87300
45.50098	54.96424	121.44220
27.29297	82.25721	547.90380
99998990.00000	99999070.00000	3694.99200

STA ER-5 APPROXIMATE ELEVATION 740

AB/2	OBS
5.000	83.570
10.000	89.600
15.000	119.400
20.000	141.700
30.000	142.600
40.000	132.200
50.000	154.200
60.000	176.800
70.000	202.700
80.000	235.700
90.000	262.300
100.000	293.400
120.000	352.100
140.000	408.100
160.000	467.400

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
2.59817	2.59817	78.91650
2.59391	5.19208	64.14477
10.29390	15.48598	147.80090
31.96866	47.45464	108.09080
16.22172	63.67636	843.04270
7.25326	70.92962	3028.52600
99998080.00000	99998150.00000	8316.20900

STA ER-6 APPROXIMATE ELEVATION 730

AB/2	OBS
5.000	98.330
10.000	108.900
15.000	111.900
20.000	122.000
30.000	131.000
40.000	150.200
50.000	162.100
60.000	178.600
70.000	197.000
80.000	216.600
90.000	233.500
100.000	256.300
120.000	293.300

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
8.93923	8.93923	92.50557
45.59259	54.53181	150.58770
24.87137	79.40318	474.05690
99999740.00000	99999820.00000	1132.99000

STA ER-7 APPROXIMATE ELEVATION 740

AB/2	OBS
5.000	78.230
10.000	85.770
15.000	97.080
20.000	105.000
30.000	120.800
40.000	139.200
50.000	157.300
60.000	180.900
70.000	202.700
80.000	223.600
90.000	252.200
100.000	277.000
120.000	328.700
140.000	387.000
160.000	441.300

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
12.20645	12.20645	76.16328
47.83915	60.04560	159.61510
22.58395	82.62955	1138.54200
99998060.00000	99998140.00000	8098.46800

STA ER-8 APPROXIMATE ELEVATION 730 FT

AB/2	OBS
5.000	89.850
10.000	94.620
15.000	106.500
20.000	116.000
30.000	127.800
40.000	145.200
50.000	164.600
60.000	194.900
70.000	223.800
80.000	257.300
90.000	298.000
100.000	331.700
120.000	415.400

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
13.17950	13.17950	87.45164
37.75817	50.93768	160.42660
12.99458	63.93226	1236.57300
99999140.00000	99999210.00000	4296.47700

STA ER-9 APPROXIMATE ELEVATION 725 FT

AB/2	OBS
5.000	81.370
10.000	89.600
15.000	96.600
20.000	100.100
30.000	102.300
40.000	113.600
50.000	115.900
60.000	130.400
70.000	142.000
80.000	157.800
90.000	174.700
100.000	193.500
120.000	231.400
140.000	273.500
160.000	319.600

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
4.60927	4.60927	75.32499
12.46529	17.07456	108.05140
34.25005	51.32461	90.80264
30.06272	81.38734	351.17000
10.61114	91.99848	1834.02500
99999050.00000	99999140.00000	2924.33700

STA ER-10 APPROXIMATE ELEVATION 742 FT

AB/2	OBS
5.000	88.590
10.000	89.600
15.000	95.940
20.000	97.770
30.000	95.000
40.000	97.520
50.000	94.250
60.000	99.530
70.000	106.000
80.000	116.600
90.000	127.800
100.000	136.900
120.000	164.300
140.000	188.200
160.000	213.100

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
9.51642	9.51642	88.07691
8.59657	18.11299	121.10080
56.77860	74.89159	75.00325
17.91609	92.80768	580.72770
99998420.00000	99998510.00000	3266.10200

STA ER-11 APPROXIMATE ELEVATION 760 FT

AB/2	OBS
5.000	85.450
10.000	76.840
15.000	82.660
20.000	81.180
30.000	82.180
40.000	82.690
50.000	80.740
60.000	87.840
70.000	92.800
80.000	103.000
90.000	108.800
100.000	123.100
120.000	143.800
140.000	172.100
160.000	198.000

REDUCED THICKNESS	REDUCED DEPTH	REDUCED RESISTIVITY
2.77414	2.77414	92.33759
6.88939	9.66354	74.83196
5.84140	15.50494	100.60360
58.84111	74.34605	67.36191
20.72688	95.07292	484.81870
99998660.00000	99998750.00000	2439.49200

FIGURE CAPTIONS

Figure 1. Location map showing the original site of the town of Valmeyer, Illinois, and the proposed town site. Line A-A' is the line of the cross-section shown in Figure 3. Line B-B' is the line of cross section shown in Figure 4.

Figure 2. Map of proposed town site showing town boundary, proposed lot layout, and mapped probable sinkholes, and the approximate extent of Columbia Quarry Company mine as traced from their mine map.

Figure 3. Cross-section A-A' through the surficial materials at the proposed town site. Locations of boreholes drilled by ISGS and IDOT, and locations of earth resistivity sounding stations, are shown. See Figure 1 for location of cross-section line.

Figure 4. Cross-section B-B' through the bedrock units from old Valmeyer on the west to the proposed town site on the east. The location of the Columbia Quarry Company's limestone mine is indicated by the diagonal-line pattern. See Figure 1 for location of cross-section line.

Figure 5. Formation of a collapse sinkhole in materials overlying karst limestone. A = Initial conditions of the undisturbed sediment over limestone. Hachured horizontal line represents paleosol (marker horizon). B = Collapse of materials into karstified limestone and the formation of a soil dome. Collapse is initiated by water infiltration and washing of sediment into solution-enlarged crevices. Vertical dotted lines represent planes of weakness caused by soil dome formation. C = Continued collapse of materials and upward movement of soil dome. D = Collapse of surface materials into soil dome. E = Smoothing of sinkhole by collapse and erosion of steep walls of sinkhole and accumulation of sediment.

Figure 6. Evolution of a "compound sink". Individual sinkholes enlarge and coalesce forming a larger closed depression with several nested sinkholes that are points of infiltration (from White, 1988).

Figure 7. Soil piping that can result from modification of surface topography and drainage, leaking water lines, and improper disposal of storm runoff (from White, 1988).

Figure 8. Map of proposed new town site showing town boundary, borehole locations, electrical resistivity sounding locations, bedrock outcrops examined, and sinkholes mapped at the site.

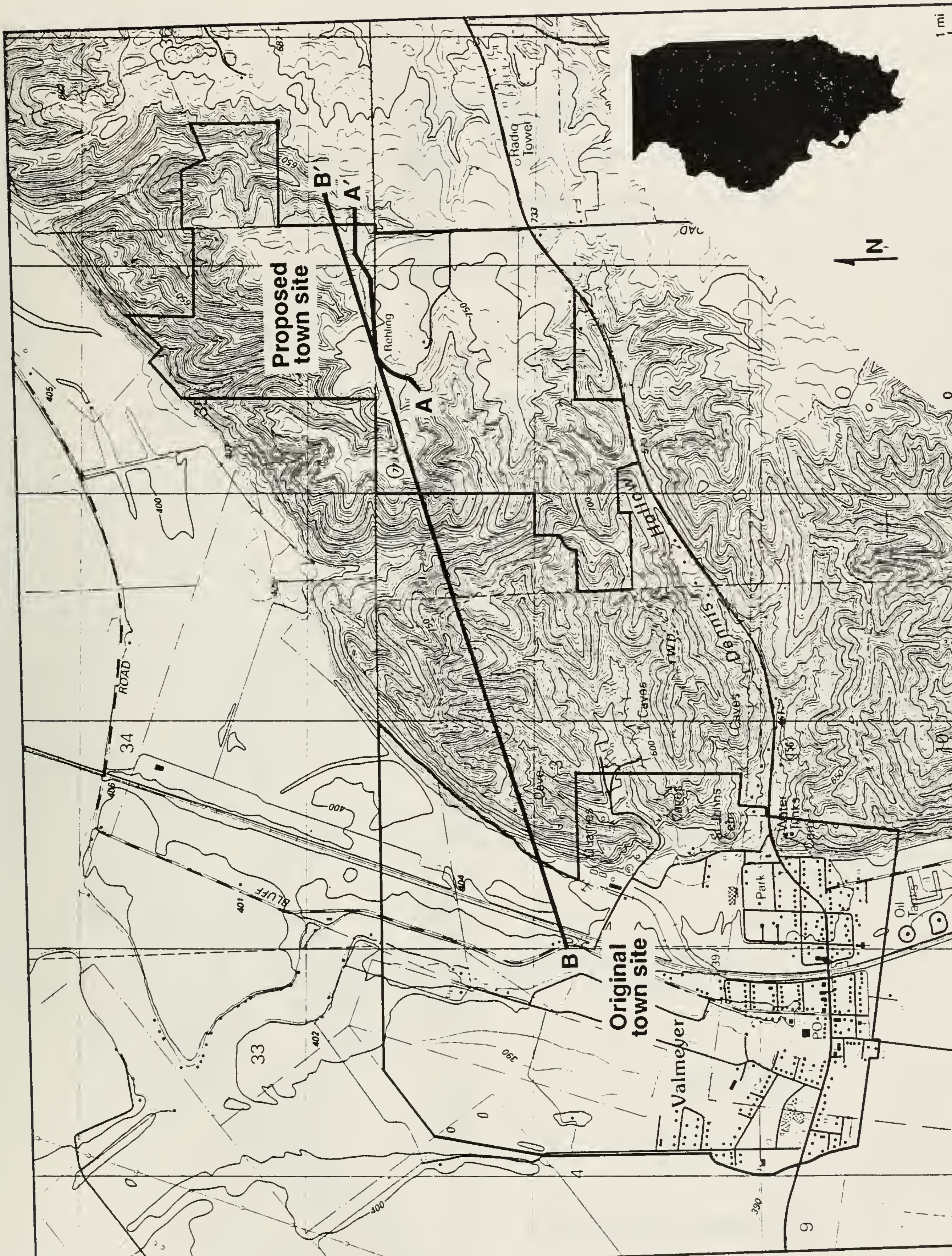

Proposed town site
Original town site
A
A'
B
B'
Valmeyer
Rehling
Dennis Hollow
Radio Tower
Park
Oil Tanks
BLUFF
ROAD
N
0
1 mi
33
34
4
9

Figure 1.

ISGS/IDOT Borings

ISGS-1 - ISGS Soil Probe # 1
IDOT-E - Eastern IDOT Boring

54 - Thickness of Quaternary Deposits

Earth Resisitivity Stations

ER-1 - Earth Resisitivity Station # 1

54 - Thickness of Quaternary Deposits

10 Foot Contour Lines

100 Foot Index Contour Lines

750 Contour Line

Town Boundary

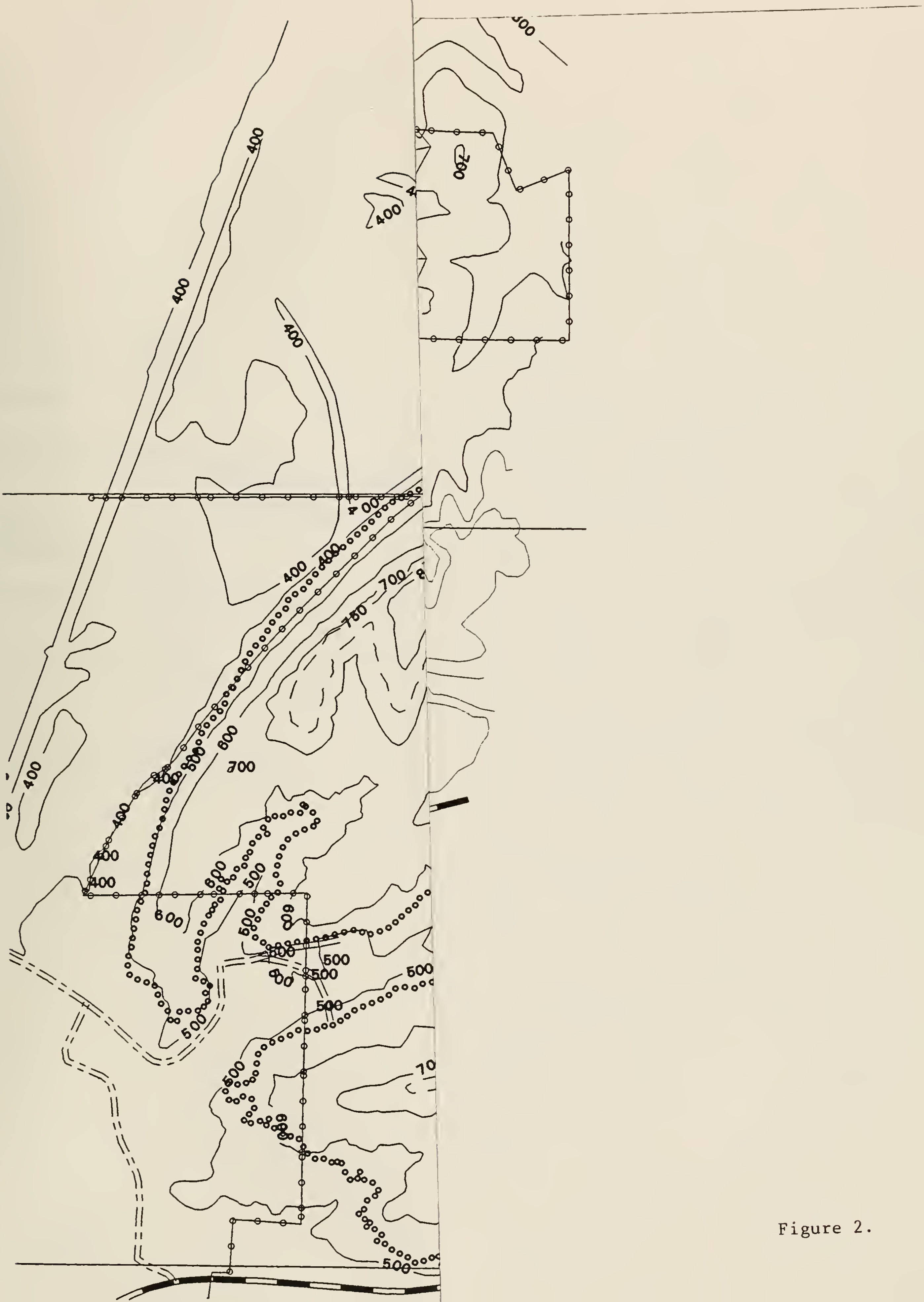
Bedrock Outcrops Examined

Limestone Mine Boundary

Sinkholes

Strike and Dip Symbol

Figures 2 and 8:
Combined key


400
400
400
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400
400
400
400
400
700
750
600
700
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600
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500
500
500
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500
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500
500
500

Figure 2.

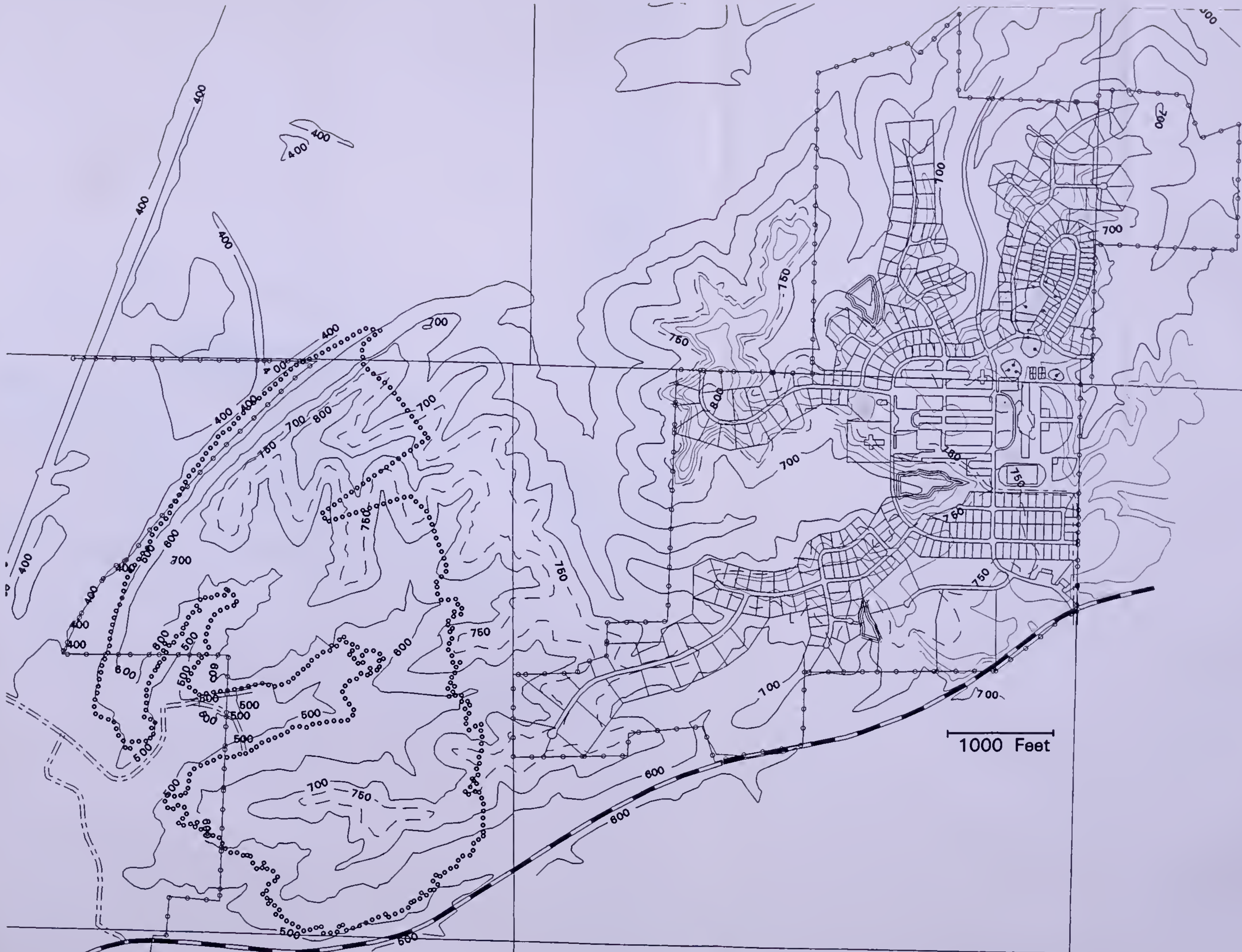
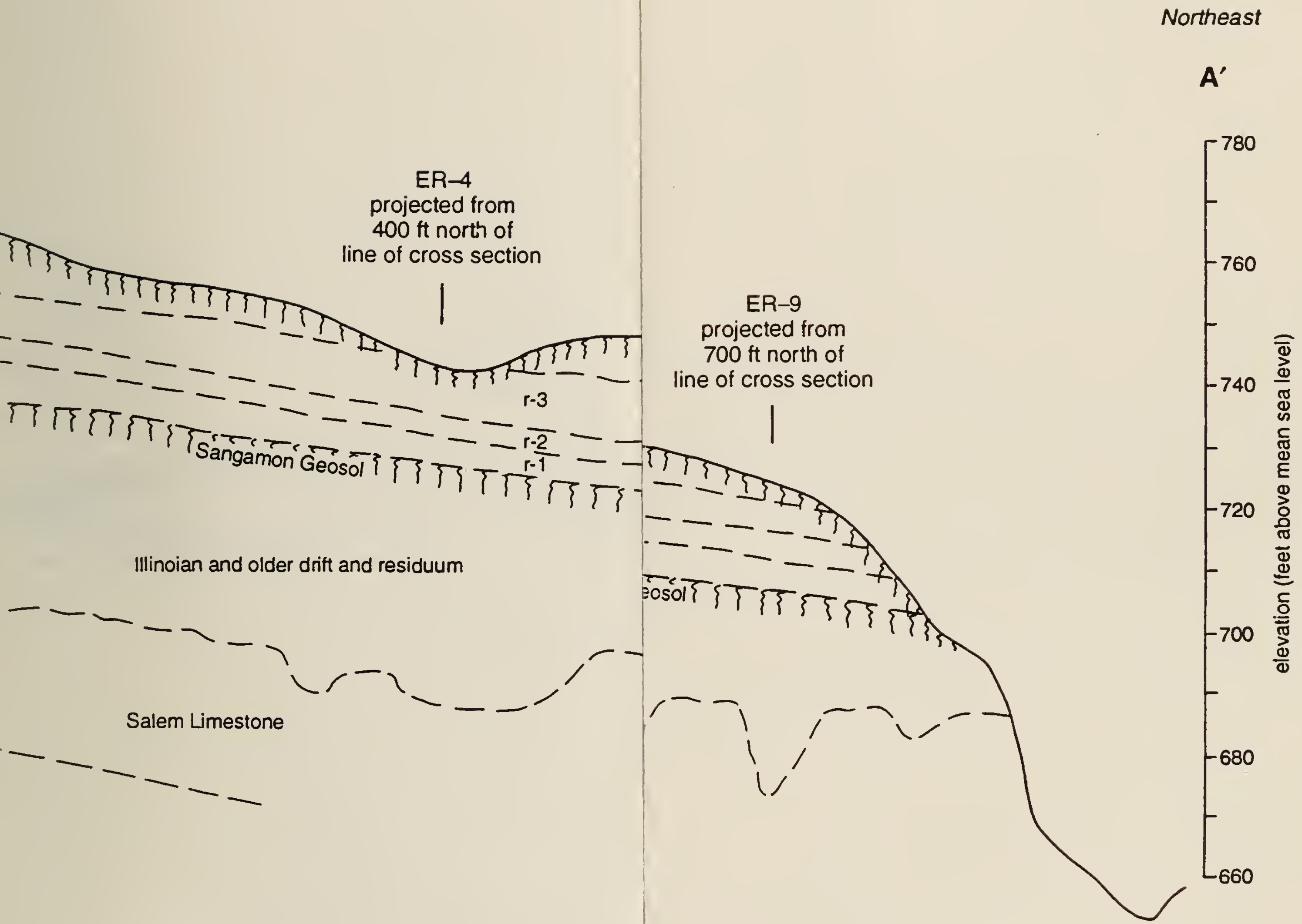


Figure 2.



E. D. McKay, November 1993

Figure 3 (cont'd)

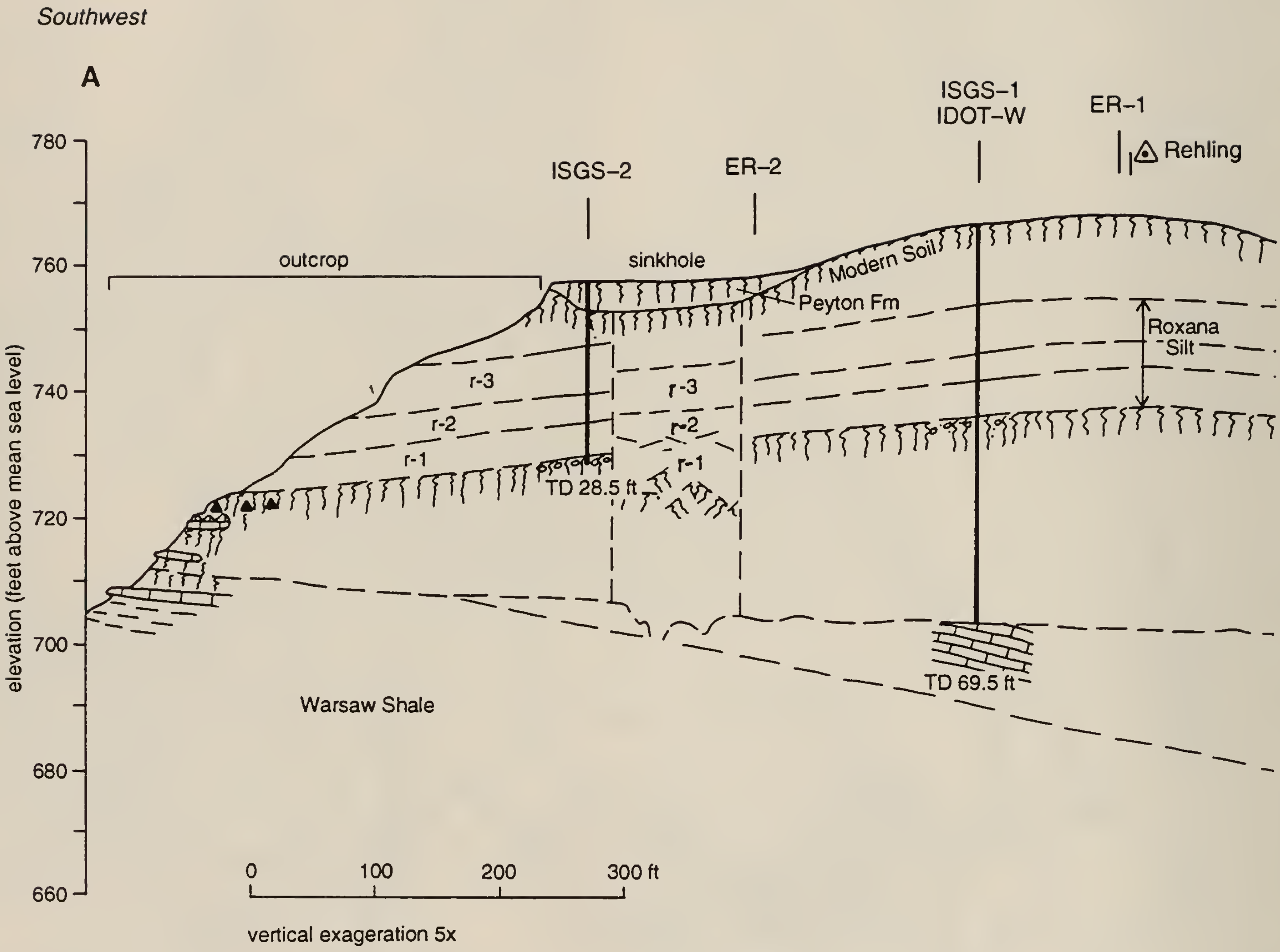
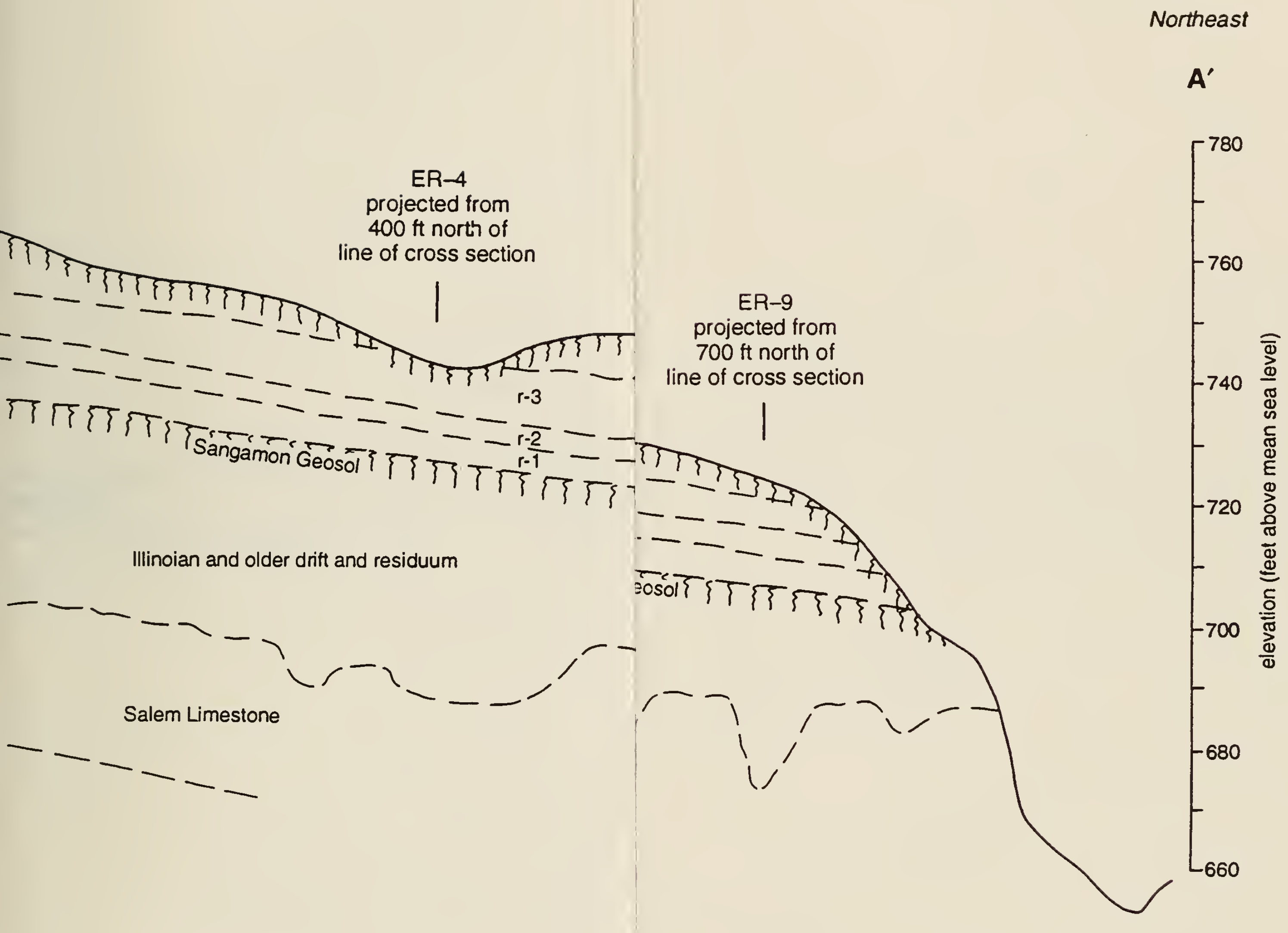

Southwest
A
ISGS-1
IDOT-W
ER-1
Rehling
ISGS-2
ER-2
780
760
740
720
700
680
660
elevation (feet above mean sea level)
outcrop
sinkhole
Modern Soil
Peyton Fm
Roxana
Silt
r-3
r-2
r-1
TD 28.5 ft
TD 69.5 ft
Warsaw Shale
0
100
200
300 ft
vertical exageration 5x

Figure 3.



E. D. McKay, November 1993

Figure 3 (cont'd)

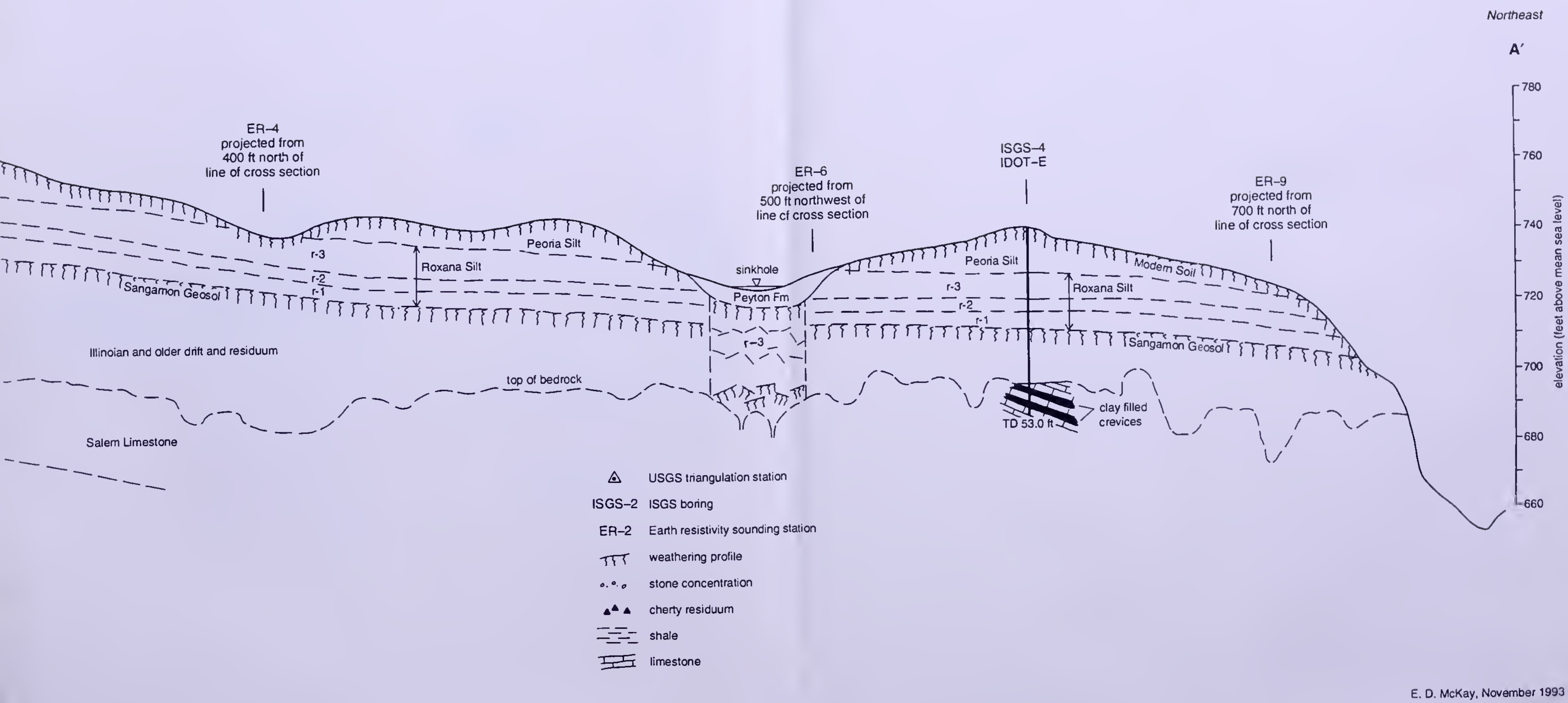


Figure 3 (cont'd)

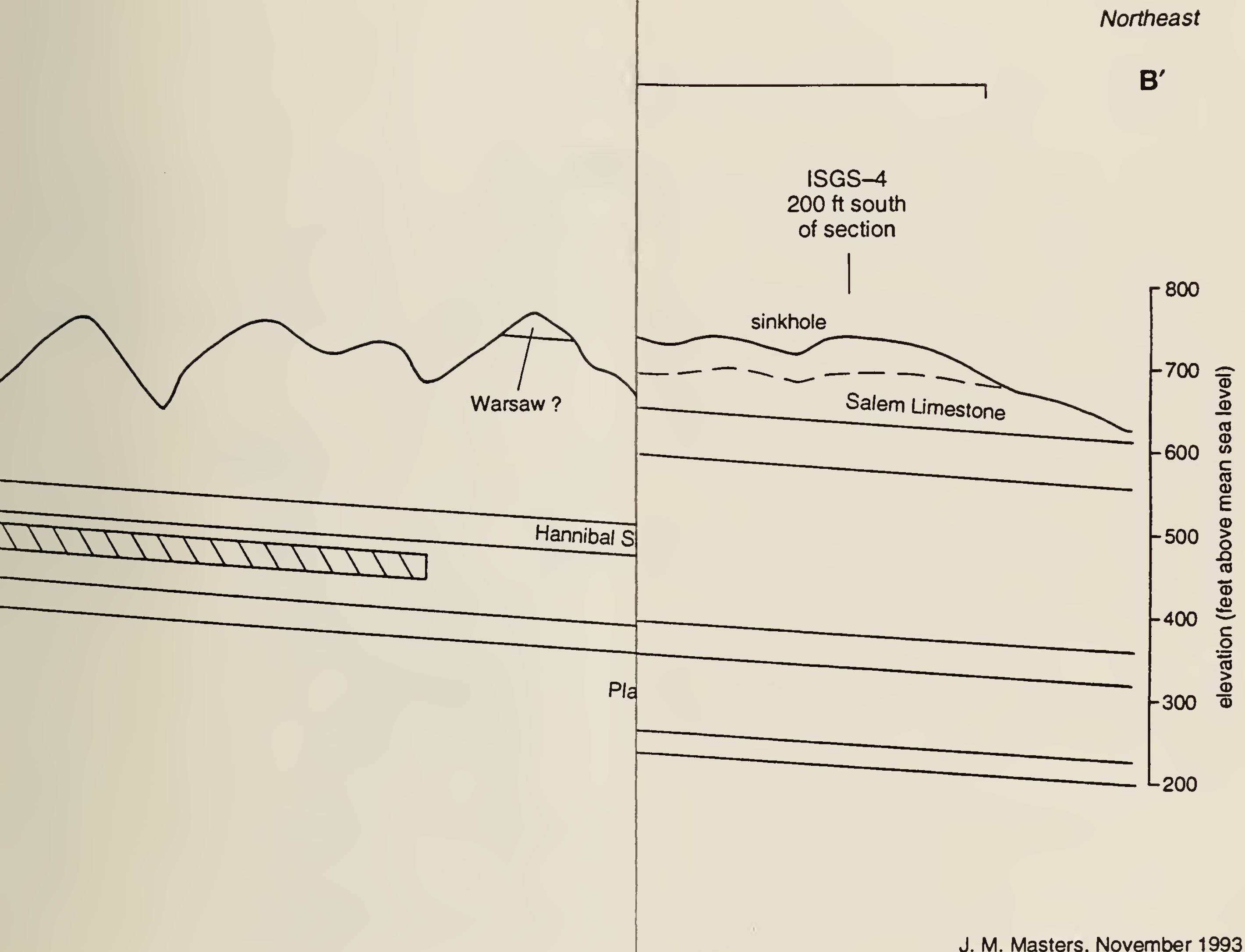


Figure 4 (cont'd)

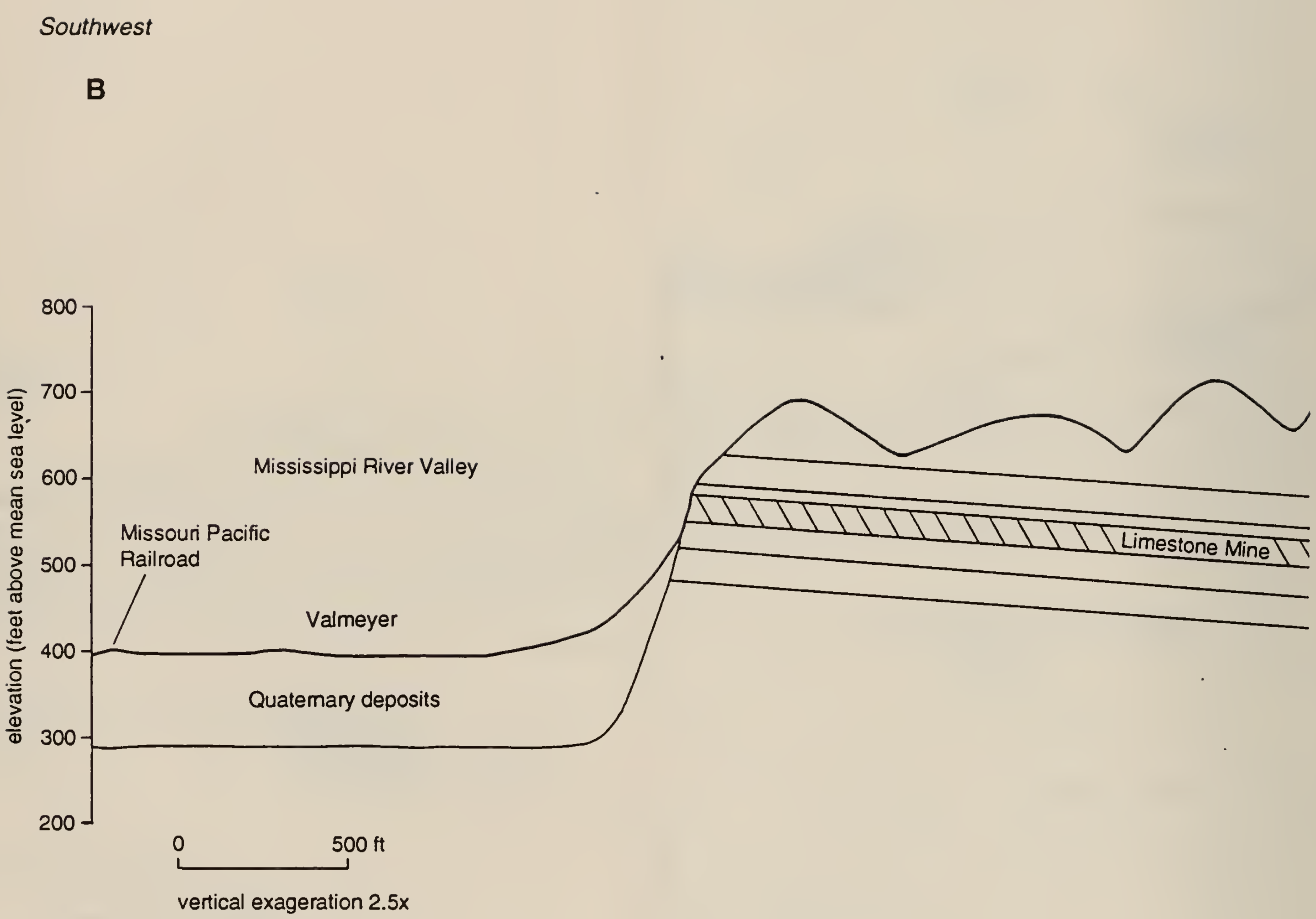

Southwest
B
800
700
600
500
400
300
200
elevation (feet above mean sea level)
Mississippi River Valley
Missouri Pacific
Railroad
Valmeyer
Quaternary deposits
Limestone Mine
0
500 ft
vertical exageration 2.5x

Figure 4.

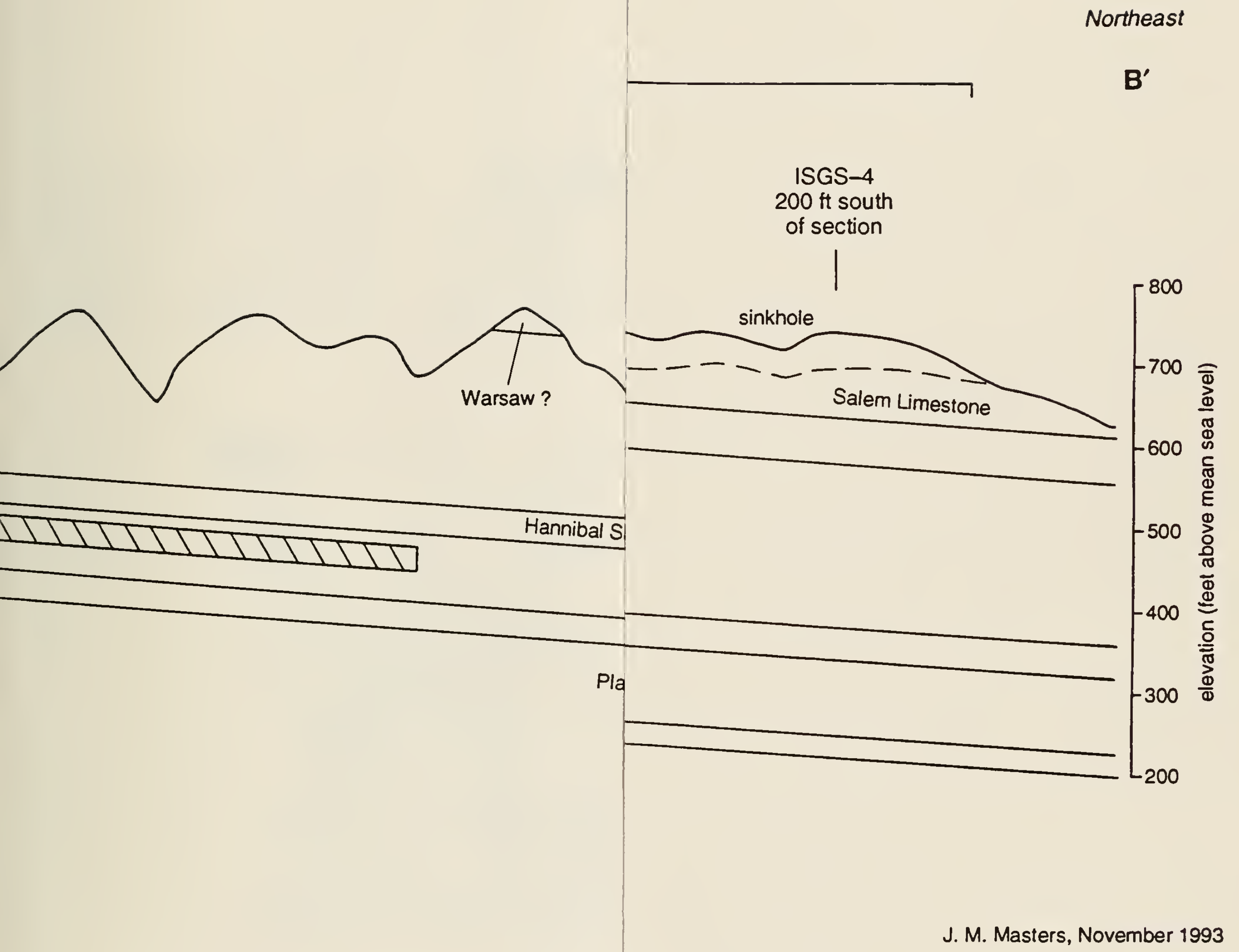
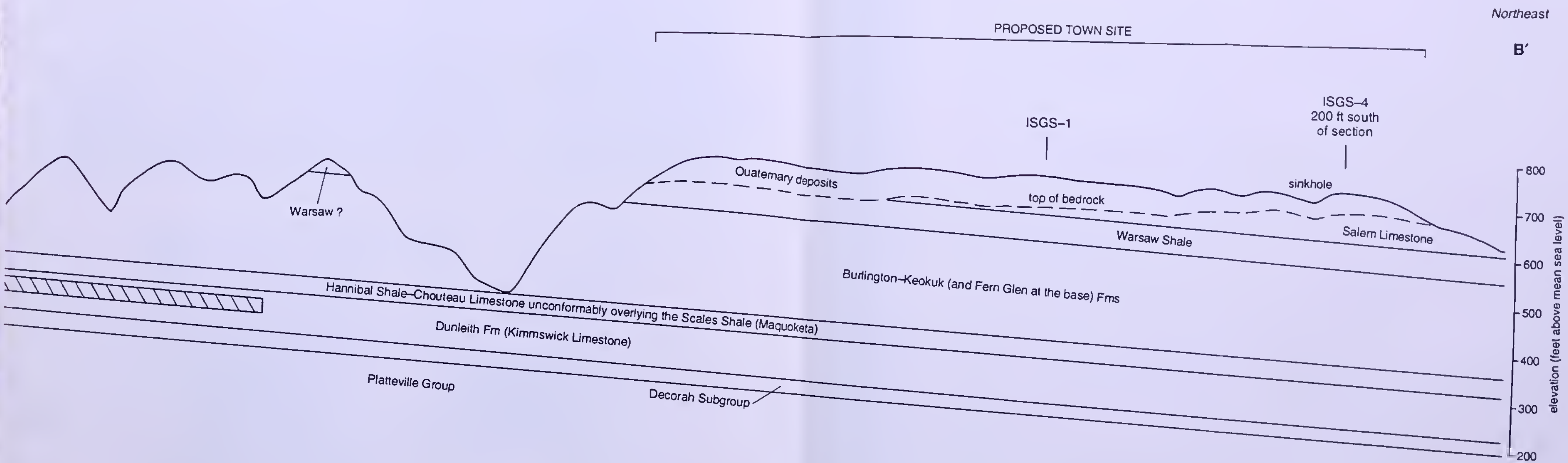


Figure 4 (cont'd)



J. M. Masters, November 1993

Figure 4 (cont'd)

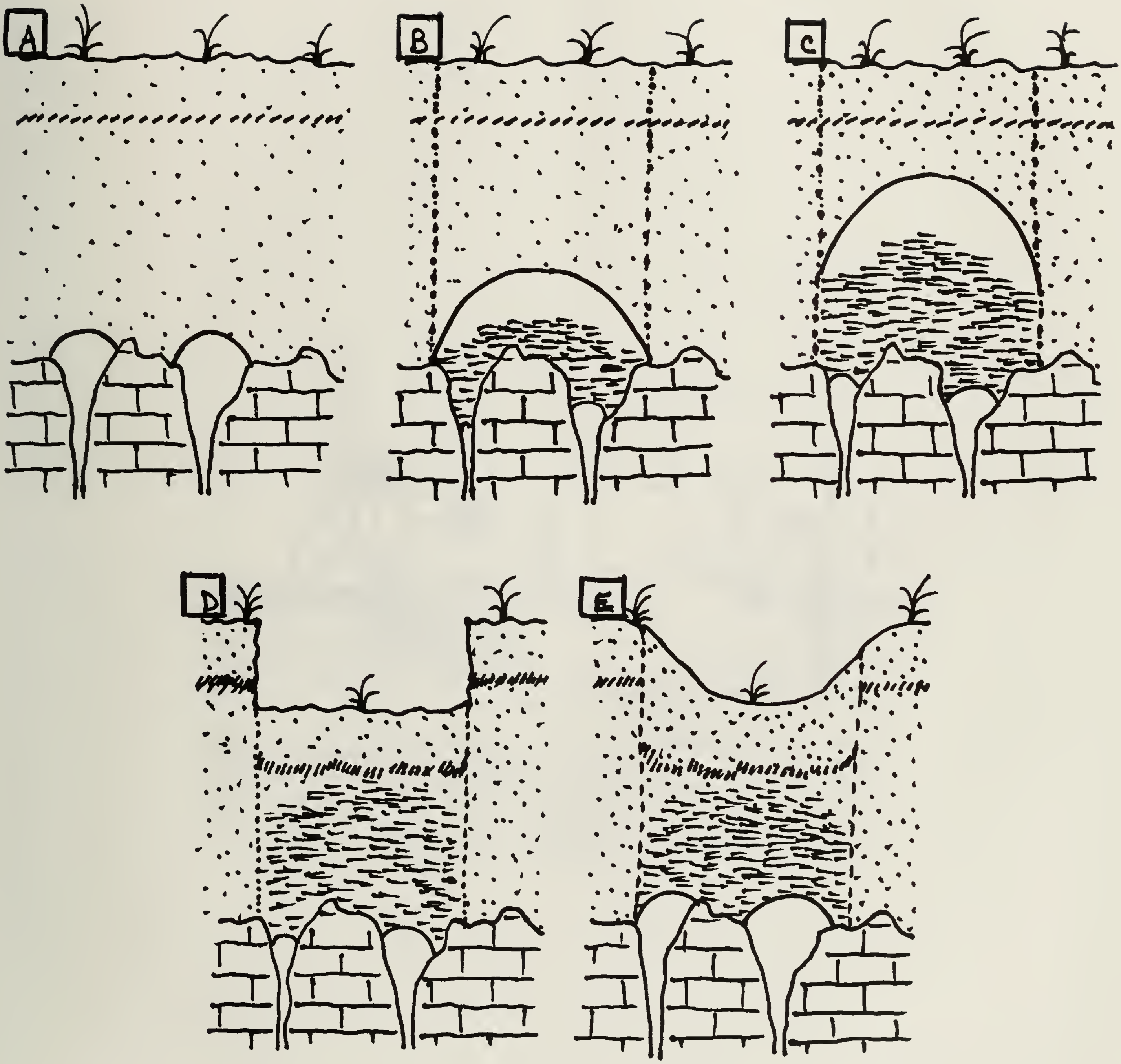


Figure 5.

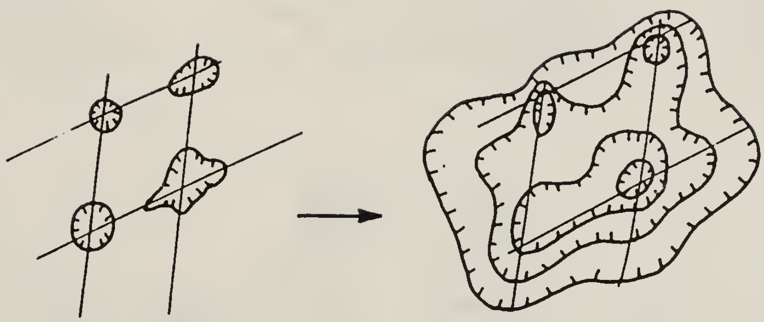


Figure 6.

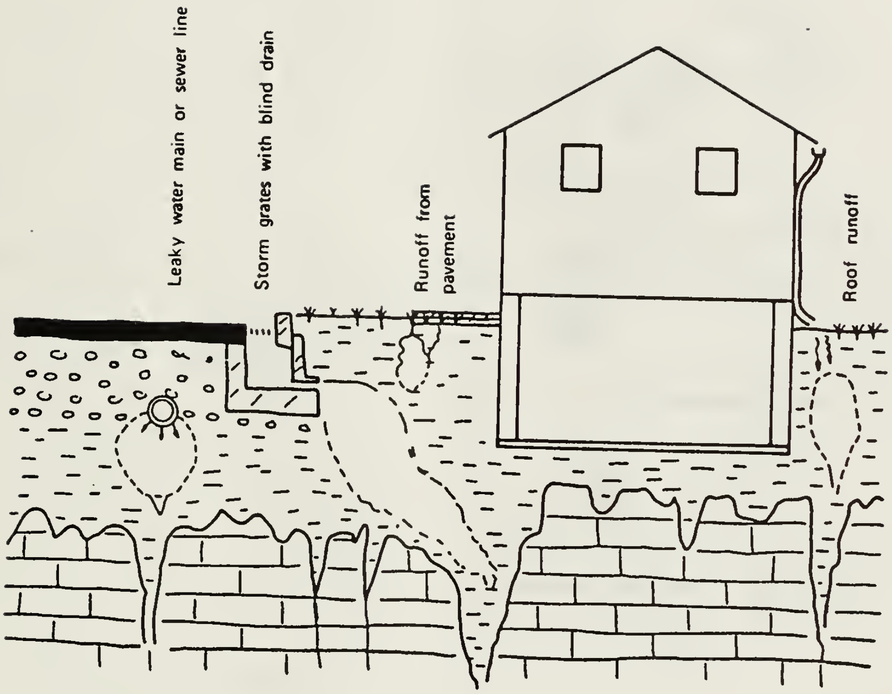

Leaky water main or sewer line
Storm grates with blind drain
Runoff from pavement
Roof runoff

Figure 7.

ISGS/IDOT Borings

ISGS-1 - ISGS Soil Probe # 1
IDOT-E - Eastern IDOT Boring

54 - Thickness of Quaternary Deposits (ft)

Earth Resisitivity Stations

ER-1 - Earth Resisitivity Station # 1

54 - Thickness of Quaternary Deposits (ft)

10 Foot Contour Lines

100 Foot Index Contour Lines

750 Contour Line

Town Boundary

Bedrock Outcrops Examined

Limestone Mine Boundary

Sinkholes

4 = amount of dip in degrees
Strike and Dip Symbol

Figures 2 and 8:
Combined key

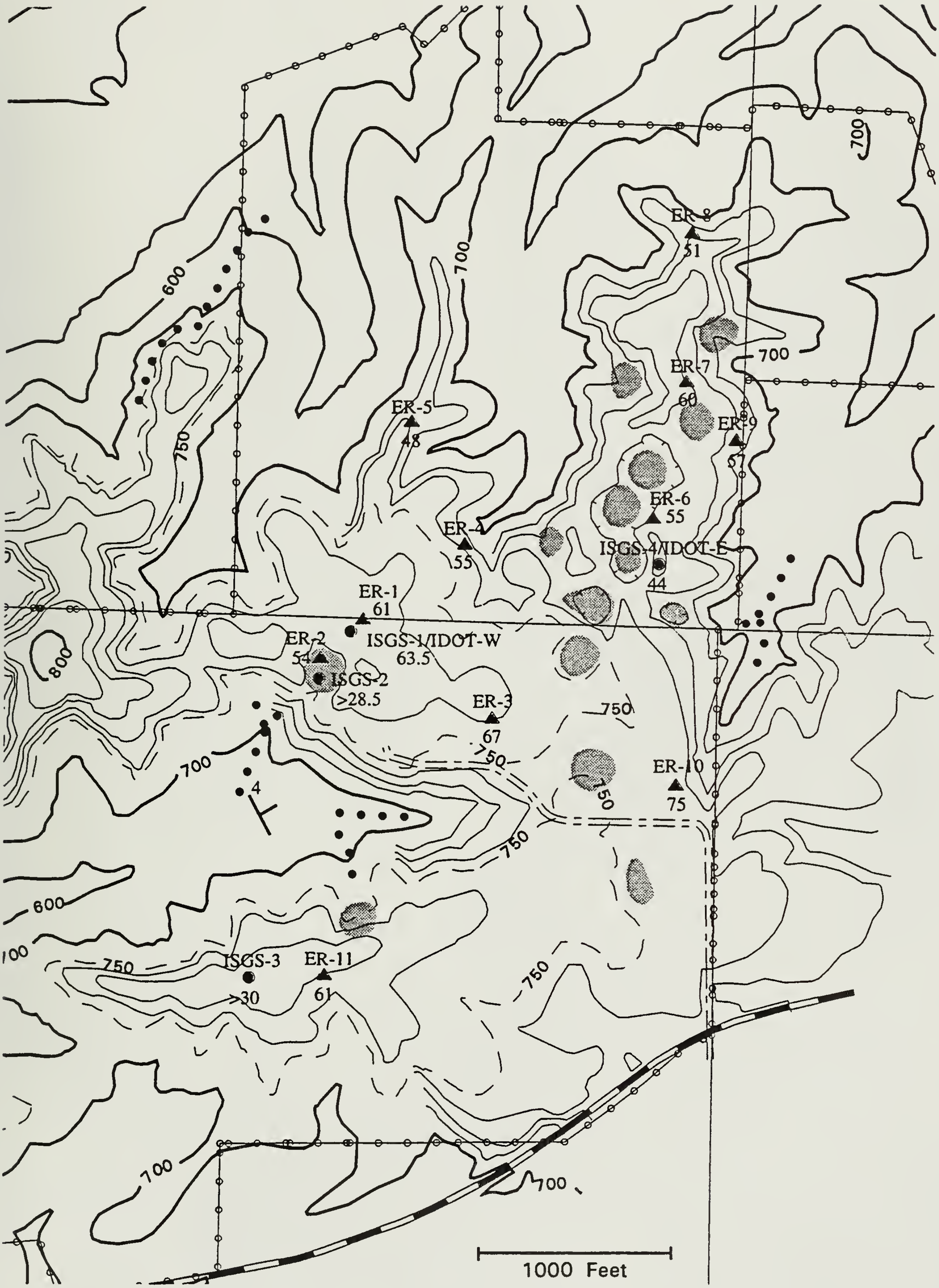

ER-8
51
ER-7
60
ER-9
57
ER-5
48
ER-6
55
ER-4
55
ISGS-4/IDOT-E
44
ER-1
61
ISGS-1/IDOT-W
63.5
ER-2
54
ISGS-2
>28.5
ER-3
67
ER-10
75
4
ISGS-3
>30
ER-11
61
600
700
750
800
1000 Feet

Figure 8.